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No. 1

I

HISTORICAL ASPECTS OF FOREIGN BODIES IN THE AIR AND FOOD PASSAGES

LOUIS H. CLERF, M.D.

PHILADELPHIA, PA.

Thomas Dent Mütter, who bequeathed a museum and founded a lectureship in this College in 1858, did not leave behind him any written evidence of an interest in foreign bodies in the air and food passages as did his biographer, Samuel D. Gross. He attained great distinction, however, in the field of surgery for clubfoot and other deformities and in plastic surgery, particularly hare lip.

The subject of foreign bodies in the air and food passages, always a source of human and dramatic as well as clinical interest, however, is not inappropriate for this occasion. The Mütter Museum houses the largest collection in the world of foreign bodies removed from the air and food passageways, The Chevalier Jackson Collection.

In reviewing the early medical literature one is impressed with the relative paucity of references to foreign bodies in the air passages. Practically all of the earlier cases were esophageal in origin. Probably the relative rarity of records of such accidents in historical literature was due to indifference or lack of imagination of the journalists as well as the medical writers of that day. While it might

Presented as the Thomas Dent Mütter Lecture of the College of Physicians of Philadelphia, December 5, 1951.

also be explained by evolutionary alterations in the protective function of the larynx or changes in the habits of man, the failure to recognize foreign bodies in the air passages undoubtedly was due to inadequate methods of diagnosis.

This assumption is reasonable when one reflects that thoracic percussion was discovered by Aurenbrugger in 1753, but that it was not accepted generally until 1839 when Skoda further investigated this method of diagnosis and originated the doctrine on which all our notions regarding percussion are based. Also, when one recalls that auscultation of the chest was really discovered by Laennec in 1816, although the method was not unknown to Hippocrates, it will be appreciated that physical examination of the chest was not well done prior to the last century. Another factor of importance, particularly in the diagnosis of laryngeal foreign bodies in adults, was the development of mirror laryngoscopy. Although first attempted in 1829, it was not until 1854 when Manuel Garcia invented the laryngeal mirror that satisfactory examinations of the larynx were possible.

Certain of the early records of foreign bodies in the air passages are of doubtful authenticity. Muys,¹ in 1690, reported in his "Practical Surgery" a case of a child, aged seven years, who died from suffocation three weeks after aspirating a bean. In 1759, Louis read his "Memoir on Bronchotomy" before the Royal Academy of Surgery at Paris. He collected all of the then known cases of foreign body, 28 in number, and presented all that had been learned concerning the subject up to that time. His work was outstanding and created favorable comment. Although reports of cases were added to the literature from time to time no systematic or elaborate study of this subject was attempted until Samuel D. Gross¹ published his "Treatise on Foreign Bodies in the Air Passages" in 1854. This contribution, celebrated in its day, still stands as a monument to the remarkable insight and the keen powers of observation possessed by the medical men of his time. During the early part of the nineteenth century much information was accumulated and definite views were formulated concerning foreign bodies. Many of the symptoms, certain of the physical signs and other important observations which then were made are still fundamentally sound and constitute an important part of the knowledge we possess today regarding this subject.

With the development of roentgenology the diagnosis of foreign body has become in great part a problem for the expert roentgenologist.

Could you imagine our predicament had we lived during the time when percussion and auscultation were in their infancy and either were little understood or little practiced by many physicians? Let me quote from Frederick Ryland,² who in 1838, discussed the diagnosis of foreign bodies in the air passages. He stated:

"The diagnosis of this accident claims the most minute attention, and we must avail ourselves of every circumstance at all calculated to throw light upon the subject. The symptoms should be minutely examined with reference to making a distinction between this affection and acute laryngitis, croup or a foreign body of large size in the esophagus. From the two first it may be distinguished by the absence of fever at first, by the very sudden manner in which the symptoms come on, by the intermissions in the difficulty of breathing, which sometimes continue for an hour or two, by the noise occasionally heard when the foreign body is impelled against the vocal cords, by the excessive violence of the cough after this occurrence, and most particularly by the chief difficulty of breathing being during the time that the expiratory process is going on, whilst in laryngitis the difficulty is in the act of inspiration."

It was generally recognized that while an aspirated foreign body usually went into the more distal portions of the airway it might be stopped at the very entrance of the larynx and produce suffocation. Concerning this Gross¹ wrote:

"How many persons have perished, perhaps in an instant and in the midst of a hearty laugh, the recital of an amusing anecdote, or the utterance of a funny joke, from the interception at the glottis of a piece of meat, a crumb of bread, a morsel of cheese, or a bit of potatoe without a suspicion, on the part of those around, of the real nature of the case! Many a coroner's inquest has been held upon the bodies of the victims of such accidents, and a verdict rendered that they died by the visitation of God, when the actual cause of death lay quietly and unobserved at the door of the windpipe of the deceased."

Of great interest are the accidents resulting when live fish held in the teeth are either aspirated or swallowed. Many primitive people as well as natives in many tropical countries have a habit of killing fish by crushing the head with the teeth or by holding the fish between the teeth so that both hands may be free to bait the hook. Not infrequently the fish in its struggle slips into the fisherman's mouth and either lodges in the pharynx, the esophagus or larynx.

In a thorough review of the literature, Gudger³ collected 31 instances of lodgment of live fish in the air and food passages. In none of these was an attempt made to remove the intruder by endoscopic means.

The earliest strictly medical report of a case of live fish impacted in the throat was presented by Dr. Eitner of Steinau, Germany in 1850. A man, aged 48 years, of large stature and strong constitution, who was given to drink, was the victim. One day, when in "his cups," he scolded his wife because she had brought to the house for his meal some very small fish. Boastfully declaring that one does not need first to cook such small trifles, one can swallow them just as they are, he followed words with actions and successfully swallowed a small live fish. Urged on by his success and anxious to further show his prowess he took another fish, unfortunately a small perch this time and decided to try it as he had the former. This fish, however, was too large to venture further than the pharynx. Here it set out its fin-rays and stuck fast. This rather large object cut off breathing and within a half hour the man died before medical aid could reach him.

Cobbold⁴ in 1863 wrote that in the anatomical museum of Edinburgh University there is preserved a whole fish 8 inches long and 2½ inches broad, which many years previously caused the death of a fisherman. The man was in a boat, drawing the net and having his hands engaged, he seized the fish by his teeth to prevent its escape through the meshes. A sudden convulsive effort carried it down his throat and after death the head was found within an inch of the cardiac orifice of the stomach. The man died from suffocation before the boat reached the shore.

Another fish story is recorded by the French physician Gautier⁵ and is dated 1785. The accident occurred in Poitou on the Biscay coast. A prosperous farmer with his servants, went to sea to fish and as is customary among the inhabitants in this region the small fish were held in the teeth of the fisherman. It seems that after the sixth try of the net he caught a small fish which he put between his teeth in order to hold it better. The fish freed itself and before anyone knew what had happened it had slipped into his trachea. Attempts were made to grasp the tail of the fish to draw it out but all was in vain. When Gautier saw the patient he was practically expiring. The doctor held the patient's mouth open with a bit of wood and with the examining finger encountered the tail of a fish at about the level of the epiglottis. An attempt was made to extract the fish but he succeeded in pulling off the tail only. There

was nothing to do but open the trachea, but the people would not consent to this operation and the patient died in less than two hours after the accident. Gautier remarked that few years go by without such accidents taking place.

There is an interesting account of a native of India, who, while fishing, caught an eel-like fish about 15 inches long. In attempting to kill the eel by biting off the head it slipped into his gullet and because of its short fins it could not be withdrawn. The man died one hour later in the greatest agony. So firmly was the eel impacted that even after death it could not be extracted and it was necessary to bury him with the eel protruding from his mouth.

Curiously, in every case of impaction of a live fish in any portion of the air or food passages, the intruder enters head first. This is very naturally to be expected since it is impossible to swallow a fish tail foremost because of the direction of the fins. Birds who live on fishes are aware of this.

It was long known that foreign bodies were found more often in the right bronchus than in the left. Although many ingenious explanations were offered to account for this, to Mr. Goodall⁶ of Dublin (1844) belongs the credit of having directed attention to the part played by the septum or carina in influencing the passage of foreign bodies in their descent to the bronchi. Gross concurred in this explanation. Browne,⁷ of Dublin, was of the opinion that impaction of foreign bodies in the air passages occurred less frequently in children than in adults. Gross' experiences did not corroborate this view, for he stated: "It is to be regretted that this gentleman has not furnished us with his reason for this opinion for which I think there is certainly not the slightest foundation in truth." The observations made by Gross have been amply substantiated.

The importance, from the standpoint of diagnosis, of a careful inquiry into the history of every case that is brought under the physician's observation was frequently emphasized by Gross.¹ Attention was directed to the first paroxysm, notably cough and a sense of suffocation which occurred with aspiration of the foreign object. Concerning the absence of symptoms, the so-called symptomless interval, it was noted that cases occasionally occurred in which the appearance of symptoms following the first paroxysm might be postponed for an unusually long period. M. Louis in his Memoir cited the case of a patient, who after the first few minutes did not experience a bad symptom for an entire year. At the end of that time he coughed up a cherry stone. In the case of Struthers,⁸ after choking

on a bone, the only symptom to suggest anything amiss in the chest was slight cough and wheeze. After 15 months, so slight were the disturbances of respiration that several surgeons, including Sir Benjamin C. Brodie, expressed the opinion that "the case was one altogether of chronic cough from which recovery might soon take place."

The occurrence of wheezing respiration and of other asthmatic manifestations was recognized by Struthers, Gross and others. In this connection the case of Dr. John M. Nooth⁹ is remarkable:

"He was seized while on duty in Quebec in 1838, with an asthmatic affection which came on almost every day for some months; it consisted of pain and a sense of weight in the left side of the chest, together with some difficulty in breathing. A few months after the first seizure there came on, in addition to other symptoms intermittent pulse and irregularity of the heart's action. He was persuaded to return to England, and two years from the commencement of a series of asthmatic attacks he arrived in London. Soon after his arrival he went to the theater. The house was crowded, and very hot; his cough became unusually severe, his respirations difficult and the irregularity of the heart's action much greater than ever. Under these circumstances, he went home and retired to bed very ill and in great distress. Lying with his face downward he continued coughing and spitting phlegm and toward morning he discovered that he had spit up a large leaden shot, about an eighth of an inch in diameter. In ten or 12 days afterwards the expectoration and cough had quite ceased and the pulse had become regular. Dr. Nooth could not be certain how this shot got into the air passages, but he remembered that he was one day seized immediately after drinking the last glass of a bottle of wine, with a convulsive cough, which continued to be troublesome for some days after and this was previous to his experiencing any uneasiness in the chest."

The significance and the mechanism underlying the production of obstructive emphysema was first described by W. F. Manges.¹⁰ Emphysema of the lung occurring in foreign body was described by Lescure¹¹ who observed the lungs of a girl, aged four years, who died 60 hours after impaction of a piece of almond shell in the upper part of the trachea. The lungs were emphysematous in their entire extent but the air had not reached the external surface of the body. In Ormerod's¹² case the left lung had been rendered emphysematous over a considerable portion of its outer surface from general dilatation of the air cells caused by a pebble lodged in the trachea at the bifurcation. The occurrence of subcutaneous emphysema, a rare complication of foreign body in the air passages, was first described by M.

Louis in his Memoir (1759). He was asked to see a patient, a girl aged seven years two days after she had choked on a kidney bean, and the presence of marked dyspnea led him to advise tracheotomy. On returning from his home two hours later, prepared to operate, he found well marked emphysema on each side above the clavicles. The child's parents refused operation and death ensued within three days. Louis' description of the mechanism underlying the occurrence of the emphysema is still regarded as authoritative and his account of the microscopic pathological findings is most interesting and instructive. I was unable to find any reference to obstructive atelectasis; however, drowned lung, pulmonary abscess and the phthisical lung, undoubtedly bronchiectasis with pulmonary fibrosis, are described most accurately.

Allan Burns¹³ was one of the first, if not the first, to notice the tendency for foreign substances, under certain conditions, to play up and down the trachea. In his observations in the case of a patient who had inhaled a plum stone, he noted that during inspiration the foreign body descended with rapidity along the trachea to the bifurcation; during expiration it was again forced up into the larynx but could not by any effort be projected through the glottic chink. During its descent and ascent it was productive of a tickling sensation along the course of the trachea. No reference was made by him to the sudden blocking of the airway when the foreign body was brought into contact with the larynx. Mr. Cooper¹⁴ expressed the opinion that in all of these cases a flapping noise is almost always heard over the cricoid cartilage. It could be discerned by placing the ear upon the structure and was produced by the object striking against the rima of the glottis. Dupuytren in 1835, stated: "There is a sign which I deem as characteristic of the presence of those bodies (foreign bodies in the trachea). It is a sensation of their striking against the sides of the canal which may be readily perceived both by the hand and the ear." These signs are now recognized as being absolutely characteristic and diagnostic of a migratory foreign body in the trachea.

From the foregoing it may be seen that many of the observations made by the earlier writers concerning the symptoms and signs of foreign body in the air passages were remarkable in their accuracy. While the development of roentgenology has changed our concepts of certain of these observations one still can accept the principles enunciated by Gross concerning symptoms as fundamental.

The methods of treatment applied in Gross' time were interesting if not particularly effective. They were considered from a med-

ical and surgical standpoint. Under medical treatment there were employed measures to promote the expulsion of the foreign body and to prevent the effects induced by the presence of the foreign substance. The former consisted largely of the use of emetics and sternutatories; for the latter, bleeding, expectorants, purgatives and counter-irritation were employed.

There were those who believed that spontaneous expulsion would relieve the patient of the intruder, particularly if nature was aided by additional forcible means, as inverting the patient or slapping him on the back. Gross did not approve of these procedures as there was always the risk of suffocation occasioned by lodgment of the foreign body and spasm of the larynx. He advanced the same objections to the use of emetics.

Sternutatories for the ejection of foreign bodies appear to have been employed at a very early period in medicine. Satisfactory results must have been rare since but one successful case was recorded. Gross suggested that this class of remedies might be beneficial if used in conjunction with chloroform. Under light narcosis irritation of the Schneiderian membrane with snuff or other substances would induce sneezing. With the air tubes in a state of complete relaxation it is easy to see how the foreign body might be ejected. As Gross stated: "Nature would be taken, as it were, by surprise."

On the basis of experience gained by Gross and others the opinion was generally held that the only real safety of a person laboring with a foreign body in the air passages consisted in bronchotomy. The hazard of foreign body, particularly suffocation, was in this way averted as the artificial aperture effectually permitted the patient to breathe with greater freedom and at the same time permitted the foreign body, if it did not escape at once, to remain in the air tubes with comparative impunity. It is of interest to note that Theophilus Bonetus recommended bronchotomy in 1650 in the case of a boy who had inhaled a piece of bone. He was overruled by the medical attendant and the child died from the effects of the accident. The first recorded case of this operation for relief from foreign body was detailed by Verduc in his "Surgical Pathology" published in 1717. A fragment of bone was extracted through the free incision in the trachea.

It was not until Gross¹ voiced his convictions so positively that opening of the trachea became the accepted method of treatment of foreign bodies in the air passages. It would have required courage for one to do otherwise after he clearly enunciated the "important

practical precept to resort to bronchotomy in all cases, the minute it is known that there is a foreign substance in the windpipe." This opinion was concurred in by the writers of that day and the trachea was opened if the surgeon arrived before the foreign body was expelled spontaneously.

On June 1, 1882, J. R. Weist¹⁵ reported on a study of 1000 cases of foreign bodies in the air passages to determine the propriety of bronchotomy in such accidents. This presentation was made before the American Surgical Association at its meeting in Philadelphia. Weist undertook this study when he found that his results in these cases were so greatly at variance with the reports of a similar kind previously published. Of 937 cases, 599 were not subjected to bronchotomy with a mortality rate of 23.2 per cent. Bronchotomy was performed in 338 with a mortality of 27.42 per cent, a difference of over 4 per cent in favor of non-interference. His conclusions are interesting. He believed that "bronchotomy should be resorted to when symptoms of suffocation are present, when a foreign body is in the larynx and there is associated dyspnea and in movable tracheal foreign body. When the foreign body causes no dangerous symptoms bronchotomy should not be performed."

The treatment of foreign bodies in the esophagus presented an entirely different problem. Until Gross presented his views on the subject it was of common occurrence to use some form of bougie to push the offender downward into the stomach. In fact in one of the very early cases reported from India, a certain gentlemen used his cane to aid the progress of a mass of meat on its way to the stomach. Gross advocated the use of curved forceps, blunt metallic hooks, a piece of wire formed in a noose or with a piece of whale bone or a gum elastic catheter furnished with a stylet or having a piece of sponge, or linen ball or something similar attached to its lower extremity. A number of ingenious instruments were devised, notably the Gross probang and the Graefe coin catcher. An interesting case is reported by Adelman (1884) who recalled the case of a man who had swallowed a piece of mutton with some of the bone. Attempts at extraction with forceps and at propulsion with the sponge probang having failed, Graefe's coin catcher was tried. This instrument was passed below the foreign body, but became so tightly wedged that it could not be withdrawn; the unfortunate patient remained with this additional foreign body in his gullet for more than two days. The coin catcher was finally loosened by means of a gum elastic catheter, which was threaded over it and when the impacted instrument had been gotten out, the original foreign body

was pushed into the stomach. The patient succumbed about a fortnight after the first accident, but quoting Adelman, it "does not seem that the fatal result was in any way caused or accelerated by the surgical mishap."

Occasionally kneading was resorted to. In a case in which the patient was threatened with asphyxia through the impaction of several large pieces of potato in the esophagus, Dupuytren managed to pinch the gullet with his fingers through the neck so as to crush the potato and thereby enable it to be swallowed.

Passage of a tube into the esophagus or stomach was inspired by the sword swallowers while examination of the larynx, trachea and bronchi was inspired by the results secured by use of the laryngeal mirror, intubation and catheterization of the larynx and trachea.

Hippocrates first suggested intubation of the larynx and trachea in cases of impending asphyxiation. This procedure was further emphasized by Desault in 1801 when he erroneously passed a feeding tube into the trachea of a patient. As a result of this accident he was able to demonstrate that the trachea would tolerate the tube for an indefinite period of time. Horace Green^{16, 17} who in 1828 attempted medication of the larynx, ultimately became adept in catheterization of the trachea and bronchi. He discovered that the mucosa of the larynx and tracheobronchial tree became tolerant to foreign substances. He reported his results before the Medical and Surgical Society of New York in 1847; his claims were condemned as "an anatomical impossibility and unwarrantable innovation in practical medicine." He was requested to withdraw from membership in the Society. In 1858 Bennett of Edinburgh described the introduction of catheters into the bronchi of seven patients. He injected the lungs 11 times and used as much as one half ounce of an eight per cent solution of silver nitrate.

The first attempt to visualize the esophagus is credited to Bonzini who began his experiments in 1795 and several years later reported that he was able to see its upper end. The esophagoscope was perfected sometime in advance of the bronchoscope. Jackson mentions he had the privilege of watching Mackenzie use a skeleton type of esophagoscope in 1890.

While attempts were made over 200 years ago by Levrez to visualize the interior of the larynx with a polished metal disc and Fisher of Boston in 1825 attempted to perform laryngoscopy with the aid of candlelight, it was not until 1854 when Manuel Garcia introduced laryngoscopy and beginning with this, attempts were made to visualize the trachea. Those who did esophagoscopy believed that

if a rigid tube could be passed into the esophagus it might also be passed into the larynx and trachea and on one occasion Rosenheim actually passed his esophagoscope into the trachea by mistake and was able to see the bifurcation but failed to appreciate the significance of his error. Kirstein¹⁸ performed his first direct laryngoscopy during April, 1895 and was able also to inspect the upper trachea. He stated in connection with examination of the trachea that the lower half is an exceedingly dangerous region. The walls, especially the left, pulsed rhythmically and while this was impressive to watch it called for greatest caution in the use of rigid instruments. Later in 1895 Killian deliberately passed a 9 mm tube into the bronchus of a male adult. Two years later he removed a piece of bone from the right main bronchus of a man aged 63 years. This probably is the first actual removal of a foreign body from the lower air passages with an endoscopic tube. Collidge at the Massachusetts General Hospital on May 11, 1898 performed the first successful bronchoscopy in this country at which time he extracted the tubular portion of a tracheal cannula from the right main bronchus of a man aged 23 years. He employed a urethroscope one half inch in diameter and passed it through the tracheal fistula. Practically all of the work up to this time was performed with the source of illumination placed externally and reflected by some means down the tube into the airway as well as into the food passages. In 1902 Max Einhorn introduced the idea of the auxiliary tube in the wall of the esophagoscope as the light carrier. This marks the first employment of a distally illuminated tube.

Subsequent to this Ingals, Jackson and Mosher utilized the Einhorn arrangement for distal illumination. Ingals reported the removal of two foreign bodies in 1904 using the Killian tube. In 1905 Jackson¹⁹ reported the successful removal of bronchial foreign bodies. It is interesting to note that both Ingals and Jackson used an obturator in their bronchoscopes in the early days. They introduced the tubes with the same technique as is employed in the passage of the O'Dwyer intubation tube. They also did their endoscopic examinations with patients in the sitting posture.

It is difficult therefore to indicate who invented these tubes. Hippocrates suggested placing a tube in the larynx and trachea to prevent asphyxiation. Practically 150 years ago it was demonstrated that a tube could be passed into the trachea although this was done accidentally. With inspection of the larynx it became apparent to all using this method that it would be desirable to be able to advance beyond the level of the vocal cords and with the development of

esophagoscopy the necessary tubes were available so that later the same principles were applied to inspection of the air passages and as a result bronchoscopy was developed.

Green's discovery, O'Dwyer's observations made in connection with the intubation tube and the invention of the incandescent electric light contributed greatly to direct examination of the larynx and tracheobronchial tree.

Killian is credited as the one who first did successful work in bronchoscopy. The idea of using a tube, however, was not his for this work had been investigated by Kussmaul who concluded that it was possible to pass large tubes into the food passages. Killian discovered and made known the fundamental work of Kussmaul who did not publish an account of his studies and as a result Kussmaul did not receive the credit and Killian did. To Jackson must be given the credit for improving the instrumentarium and bringing it to its present high state of perfection. In addition he made peroral endoscopy an important part of medical science, popularized the method among the medical profession and also made them "foreign body conscious." As a result a successful plan of treatment of foreign bodies in the air and food passages has been perfected and the mortality rate has been reduced from a frightfully high level to a rate not exceeding 1 to 2 per cent.

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II

ETIOLOGIC CLASSIFICATION OF DISEASES INVOLVING THE EXTERNAL EAR

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Although the skin of the external ear has certain features which are peculiar to it, the diseases affecting the ear are similar to those seen on the skin of other regions of the body and they may be classified in a similar fashion. If the diseases of the external ear are viewed with this broader perspective, we can better understand them and undertake their therapeusis from a more rational point of view.

A strict etiologic classification cannot be expected at this time because the causes of these diseases are not entirely understood; the causes are frequently multiple and overlap and some diseases are difficult to classify on an etiologic basis, yet lend themselves to morphologic classification.

The following classification has been based upon data obtained from the available literature and our own experience in dealing with infections of the ear and other parts of the body.

I. Diseases of Unknown Etiology

A. Malfunction of Skin Glands

1. Seborrheic Dermatitis
2. Diffuse External Otitis
3. Asteatosis (Dry Ear)
4. Infantile Dermatitis

B. Miscellaneous

1. Lupus Erythematosus
2. Psoriasis
3. Lichen Planus
4. Pemphigus
5. Other Diseases

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II. Diseases due to Infections

A. Bacteria

1. Furunculosis
2. Impetigo
3. Pyoderma
4. Ecthyma
5. Cellulitis
6. Erysipelas
7. Perichondritis
8. Tuberculosis
9. Leprosy

B. Fungi and Yeasts (Otomycosis)

1. Saprophytic
 - a) Aspergillosis
 - b) Penicilliosis
 - c) Mucormycosis
2. Pathogenic
 - a) Superficial
 1. Moniliasis
 2. Microsporosis
 3. Trichophytosis
 4. Epidermophytosis
 - b) Deep
 1. Actinomycosis
 2. Blastomycosis
 3. Others

C. Virus

1. Myringitis Bullosa
2. Herpes Simplex
3. Herpes Zoster
4. Molluscum Contagiosum
5. Variola
6. Varicella

D. Protozoa

1. Syphilis
2. Yaws

E. Parasites (Animal)

1. Pediculosis
2. Scabies (Infants)

III. Neurogenic Eruptions

- A. Simple Pruritis
- B. Neurodermatitis
- C. Neurotic Excoriations
- D. Artifact Dermatitis (Malingering)

IV. Allergic Dermatitis

- A. Contact Dermatitis (Dermatitis Venenata)
- B. Atopic Dermatitis
- C. Drug Eruptions
- D. Infectious Eczematoid Dermatitis
- E. Physical Allergy

V. Traumatic Lesions

- A. Contusions and Lacerations
- B. Surgical Incisions
- C. Hemorrhages
 - 1. Hematoma
 - 2. Vesicles and Bullae
- D. Burns
- E. Frostbite
- F. Radiation Injury
- G. Chemical Injury

VI. Senile Changes

VII. Vitamin Dyscrasias

VIII. Endocrine Dyscrasias

IX. Malformations

X. Tumors

Most of the material is in the form of definition rather than in detailed description. For those who wish further information pertinent references are supplied. In order to restrict the size of this report, discussion of rare and unusual diseases, malformations and tumors has been omitted.

I. Diseases of Unknown Etiology.

A. Malfunction of Skin Glands.

- 1. Seborrheic Dermatitis:^{8, 9, 10} This consists of an erythematous, greasy, scaly eruption which affects primarily the scalp, eyebrows,

nose, nasolabial folds, neck, ears, sternal region and hairy region of the groin. The process may be localized or very extensive, a characteristic finding being a greasy scale which, in separating itself from the epidermis, flakes and crumbles. When ear findings are present, they are usually associated with seborrhea of the scalp. In such instances the post-auricular regions, concha and external auditory canal may be involved.

The picture is frequently not clean cut because of secondary changes imposed by excoriations, especially as found in persons who are emotionally tense and high strung. In such cases the skin of the pre-, post- and infra-auricular regions becomes inflamed, crusted and weeping. Changes produced by over treatment can cloud the picture in such a way as to make it difficult to distinguish this from neurodermatitis. In addition, seborrheic dermatitis must be differentiated from contact dermatitis and lupus erythematosus.

2. Diffuse External Otitis:¹¹ This is a symptom complex seen mainly during hot, humid weather. It may occur as a mild, moderate or severe disease and is diagnosed as acute or chronic according to the symptoms and findings.

The mild acute case has slight pain on manipulation of the auricle. The skin of the ear canal reveals some edema, slight redness and a coating of odorless, adherent secretion or exfoliated debris. Some loss of luster of the drum is seen.

In the more severe acute cases, patients complain of intense pain on mastication and on manipulation of the external ear. Although the auricle appears uninvolved, there is marked periauricular edema and partial or complete obliteration of the canal lumen by the edematous walls. Gray or green seropurulent secretions and sheets of exfoliated debris are seen in the remaining lumen. The skin of the canal is thickened, purplish red in color and may have a papular appearance resembling gooseflesh, particularly on the superior and inferior walls. Characteristically, there is a smooth convex sagging of the superior canal wall extending to the tympanic membrane. Under otoscopic magnification, discrete, raised, milky white papules and flat grayish vesicles are seen with intervening zones of erythema. These changes in the walls result in an obliteration of the canal lumen and therefore the tympanic membrane cannot be well visualized.

In the chronic case a variable thickening of the skin of the auricle and ear canal with a consequent reduction of the lumen of the entire canal is found. Dry, adherent, exfoliated debris often

lines the canal, while there may be a gray-brown or greenish secretion, with a fetid odor, coating the skin and filling the tympanic recess. Papules and vesicles are sometimes seen and the drum loses its luster, becomes thickened and shows loss of some detail.

In cultures of these ear canals almost invariably an abundant growth of Gram-negative bacilli is obtained while occasional fungi are seen. Stained smears reveal myriads of bacilli and epithelial cells.

3. Asteatosis (Dry Ear):⁸ A deficiency in sebaceous secretion brings about a dry condition of the skin of the ear canal. A similar condition may be produced by the application of medications which remove the sebum from the surface of the skin; these findings may occur in association with eczema or ichthyosis and are frequently observed in old age. In cold weather symptoms resulting from these changes become more prominent.

4. Infantile Dermatitis:¹² It is believed that the typical clinical changes seen here are due to some malformation of the skin appendages occurring in children and in young adults. Attention is first directed to the ears by repeated rubbing and scratching of the auricle. This irritation often occurs without obvious external disease of the ears or skin of the body. Examination reveals an absence of edema or adenopathy. There is a small amount of dry crusted debris at the entrance to the auditory canal and a variable amount of soft, pale, yellowish, moist, fetid secretion in the lumen of the canal. A rapid accumulation of secretion occurs in the ear canal within two to four weeks. Cultures frequently reveal *Corynebacteria* (diphtheroids) and smears show myriads of epithelial cells and bacilli.

B. Miscellaneous: There are a variety of skin diseases the causes of which to this time have not been elucidated. Only a few of these more common diseases will be discussed.

1. Lupus Erythematosus:⁸ There are three different types of this disorder: the chronic discoid, the subacute and the acute types. The discoid type usually consists of erythematous, circumscribed lesions presenting a firm adherent scale. In time pigmentation and atrophy may occur. The external ear is a frequent site of involvement especially on the lobule and concha. The acute and subacute types are accompanied by systemic manifestations such as fever and weakness.

2. Psoriasis:⁸ This is a chronic inflammatory dermatosis frequently found on the scalp, elbows, knees and nails. The lesions are superficial and pink and have a scale which when scraped off re-

sembles mica. The eruption on the scalp may be quite scaly and at times indistinguishable from seborrhea; however, as a rule, these lesions are not as greasy as those of seborrhea and there is a greater tendency for the formation of circumscribed plaques of varying size. It frequently extends from the scalp to the ear where the eruption may be about the postauricular fold or about the external auditory meatus. Generally there is evidence of psoriasis elsewhere on the body and other possible sites should be examined.

3. Lichen Planus:⁸ This is an inflammatory disease characterized by distinctive annular and linear patches of flat, angulated, pinhead sized papules which have a predilection for the flexor surfaces of the extremities and trunk. The surface of the lesions is dry and shiny with a tendency to scaling. Mucous membranes are affected in about 25% of the cases, the lesions occurring on the inside of the cheeks, the palate, lips and tongue.

4. Pemphigus:^{8, 9} This is a lethal disease characterized by occurrence of large flaccid bullae of the skin and mucous membranes arising from non-inflamed bases, and accompanied by progressive loss of weight, weakness and eventual death.

II. Diseases due to Infections.

A. Bacteria.

1. Furunculosis:¹⁴ The circumscribed, erythematous, pustular lesion surrounds a hair and is invariably due to staphylococci.

2. Impetigo:¹³ The eruption is a superficial honey-colored crusted process overlying the epidermis and may be caused by a streptococcus, staphylococcus or both.

3. Pyoderma:¹⁴ The lesions are somewhat deeper, are boggy and commonly follow trauma. Staphylococci are usually the causative organisms.

4. Ecthyma:¹⁴ Though not frequently seen in the ear, this is an inflammatory process which generally affects the epidermis and cutis, and which may eventuate in scarring and constriction of the canal. In this instance the etiological organisms are in most cases a mixed flora (anaerobe-aerobe).

5. Cellulitis: In this condition, the skin becomes erythematous, warm and indurated without any definite sharp border; any part of the ear or periauricular tissues may be involved. Lymphangitis and regional adenopathy are not uncommon and there may be associated chills and fever. Though sometimes of unknown causation, the af-

fection may follow trauma, insect bites or contact dermatitis. The etiologic agent is generally a streptococcus or staphylococcus.

6. Erysipelas:¹⁵ This is a contagious disease commonly caused by hemolytic streptococci and occasionally by staphylococci which gain entrance to the skin through a hair follicle, abrasion or contusion. The involved area is warm and tender and has a characteristic smooth, elevated, tense, shining, red, indurated appearance with a sharp line of demarcation between the inflamed and the normal skin. Rapid extension occurs around the auricle onto the face, neck and postauricular regions. There is associated pain, fever and anorexia. In the more severe cases, vesicles and bullae may form.

7. Perichondritis: This is a slowly developing localized or diffuse inflammation of the cartilage of the external ear which may follow infections, frostbite, laceration, contusion or ear surgery. The auricle becomes warm, soft, reddish and thickened on its anterior surface and there is sharp demarcation from the uninvolved lobule. Serum or pus is found between the cartilage and perichondrium and interferes with the nourishment of the cartilage. An idiopathic type is said to occur. Deformation of the auricle is frequent.

8. Tuberculosis:^{16, 17} *Lupus vulgaris*, the most common form, is characterized by ulceration, formation of apple jelly nodules and scarring. It is frequently independent of any pulmonary lesion.

9. Leprosy:¹⁸ In this disease some of the most striking changes take place in the ear; the auricle becomes infiltrated, nodular and enlarged. As a rule, similar changes are observed on other parts of the face.

B. Fungi and Yeasts (Otomycosis).

1. Saprophytic:^{8, 19, 20, 21} Diseases falling under this heading are chronic or recurring and are observed most frequently in tropical or subtropical climates. The organisms reported in the literature as causing otomycosis are classified as belonging to the following: *Aspergillaceae*, *Mucoraceae*, yeastlike fungi, dermatophytes, *Actinomycetaceae* and miscellaneous fungi.^{22, 23} The patient complains of intense itching, feeling of fullness in the ear, difficulty in hearing and later severe pain. Examination may reveal moist cerumen intermixed with exfoliated scales and sheets of epithelium, or the depths of the canal may be filled with wet greyish "blotting paper" debris.⁴ In uncomplicated cases the organisms may be seen as green, black or white filamentous structures not unlike those seen on an agar culture. Moderate edema of the canal walls and tympanic membrane may be pres-

ent in the more severe cases with complete obliteration of all the usual landmarks. There is rarely any periauricular edema or adenopathy unless secondary infection occurs. Direct wet unstained smears reveal the presence of mycelia, spores, many neutrophils and myriads of epithelial cells.²⁴

2. Pathogenic.²²

a) Superficial: In the temperate zone the pathogenic fungi are not cultured as frequently as believed in the past. The organisms occasionally encountered are *Epidermophyton inguinale*, *E. floccosum*, *T. gypsum*, *T. purpureum* and *Monilia albicans*.

b) Deep:^{25, 26} Blastomycosis, Actinomycosis and Sporotrichosis as a rule affect the skin of the rest of the body. Any granulomatous lesion involving the external canal should be examined for the deeper fungus infections.

C. Virus.²⁷

1. Myringitis Bullosa:^{28, 2} Always observed in this disease is an acute vesicular or hemorrhagic eruption involving the tympanic membrane and the adjacent canal wall and usually associated with or following an acute upper respiratory infection. There is severe pain in the ear which subsides after a short period of time. Spontaneous rupture of the bleb is followed by slow resolution usually without local infection. The etiologic agent is not known but is presumed to be a virus.

2. Herpes Simplex:²⁷ The lesions may occur anywhere in the body. They consist of multiple thin-walled tense vesicles which start with burning, smarting and tingling and then effluoresce through the vesicle stage to become crusted. The etiologic agent is a virus and can be isolated from the vesicle fluid. No lasting immunity occurs.

3. Herpes Zoster:^{27, 29, 30} The eruption is unilateral and consists of groups of tense vesicles on erythematous bases. It follows the course of a cutaneous nerve. The process may be primary or secondary. It is described as primary when caused by a virus infection of the dorsal root ganglion and as secondary when brought about by disturbances of the dorsal root ganglion by pressure of new growth or infiltration. Permanent immunity follows one attack of this disease.

4. Molluscum Contagiosum:^{8, 31} This eruption is seen mostly in children and consists of one or more small, circumscribed, raised,

flesh-colored, waxy nodules. Each lesion presents a central umbilication. When only a solitary lesion is present it may resemble basal cell carcinoma.

5 and 6. Variola and Varicella:⁸ The picture presented by the lesions as they occur in the ear is like that elsewhere on the body.

D. Protozoa.

1. Syphilis:³² This disease presents many cutaneous manifestations. Three stages are recognized.

a) Primary (Hard chancre): The lesion is an indurated, ulcerated, granulomatous lesion accompanied by regional adenopathy. Extragenitally it may be observed on the auricle. Since syphilis should always be suspected, dark field and blood serology ought to be performed on every such lesion.

b) Secondary: The many forms of this stage include the macular, nodular, roseola, papular, follicular and corymbose. Characteristic of these forms is a copper-like color and frequent induration.

c) Tertiary: The lesions are manifestations of late syphilis and are usually nodular or ulcerative.

2. Yaws:³³ Although bearing a close clinical resemblance to syphilis, this disease does not have so serious an import. A tropical disease, it is caused by the organism *Treponema pertenue*.

E. Parasites (Animal).⁸

1. Pediculosis: The lesions are characterized by edematous, erythematous papules which may present a central punctate where the proboscis pierced the skin. Sometimes vesiculation and bullae result.

2. Scabies (Infants): This eruption is an itching dermatosis which characteristically occurs in the form of excoriated papules and burrows on the trunk and extremities. Ear lesions are at times found in young children and infants. The etiological organism is the *Acarus scabiei*.

III. Neurogenic Eruptions.^{34, 35, 36}

A. Simple Pruritis: There is itching only, which may be minimal or very severe, without visible lesions. This is predominantly an affliction of women in the middle-aged group. Such persons are tense, hyperactive and excessively energetic; they may tug and scratch

at their ears and become vociferous about the severity of their sufferings. On the other hand, it must be kept in mind that this itching may be associated with many medical states such as diabetes, jaundice states, nephritis, the lymphoblastoma group of diseases, sensitivity to contactants and dry skin.

B. Neurodermatitis.

1. Localized (lichen chronicus simplex): This is characterized by various sized excoriated, scaly, dry patches in which there is thickening of the skin and increase in the skin markings. The patches are more sharply circumscribed than in seborrheic dermatitis. Other isolated plaques usually may be seen on the sides and back of the neck, eyelids, antecubital and popliteal areas and on the ankles.

2. Disseminated: The eruption occurs on the face, neck, cubital and popliteal spaces and sometimes is universal in its distribution. Lesions are erythematous, dry and scaly and are usually excoriated. Not infrequently the ear partakes in this reaction. Of psychogenic etiology, it frequently is seen in young to middle-aged tense women. It must be differentiated from atopic dermatitis.

C. Neurotic Excoriations: The lesions are scratched pickmarks which are self-inflicted by neurotic individuals who do not inflict them purposely but because they have compulsions. Such lesions are recognized by noting the psychological state of the patient and by the accessibility of the area scratched.

D. Artifact Dermatitis (Malingering): Lesions are inflamed, crusted, ulcerated and may assume different geometric appearances, such as linear and angular formations. The fact that they do not follow natural forms suggests the diagnosis. They are at times purposefully self-inflicted usually in order to escape some unpleasant duty or to create sympathy.

IV. Allergic Dermatitis.^{37,38}

A. Contact Dermatitis (Dermatitis Venenata): The allergic inflammation herein produced is a result of the contact of the offending substances (animal, vegetable or chemical) with the hypersensitive epithelial cells of the epidermis. The reaction consists of erythema, edema, vesiculation, bullous formation and crusting, and is accompanied by a sensation of burning and itching in varying degrees. Involution occurs when the contactant is removed or neutralized. The usual substances responsible for this type of dermatitis in the ears are medications used in the ears, cosmetics used on the scalp and face or other materials such as jewelry and the temples of eyeglasses.

Most important among them are hair lacquers, perfumes, colognes, earrings and medications. Actually, any medications used in or around the ear is potentially capable of sensitizing the site to which it is applied.

B. Atopic Dermatitis: This is frequently associated with dermatitis on the eyelids, face, sides of neck, popliteal and cubital fossae. The skin affected is erythematous, scaly and excoriated. Such a reaction may occur in any part of the ear, in which case the area involved may become thickened and inflamed. In fact, it is quite possible that many of the scaly auricular irritations may be only localized atopic dermatitis.

In about 50% of the cases there is an associated history of other allergic diseases such as asthma, hay fever, migraine and urticaria. A familial history of these diseases is frequently found. Such patients present a high percentage of passive transfer bodies in their blood serum. This disease does not respond well to the allergic approach, however, and there is thought to be some other factor which is necessary for the reaction to occur.

C. Drug Eruptions:³⁷ Morphologically the drug eruption may assume any form from a simple pruritis to erythema, papule formation, vesiculation and bullae formation. Any drug is capable of producing specific sensitization with very few exceptions. Some of the common offenders are penicillin, sulfa drugs, barbiturates, salicylates, bromides, iodides, arsenic and quinine. As a rule, the rest of the body is also affected but the eruption may be "fixed" to the ear alone.

D. Infectious Eczematoid Dermatitis:³⁹ In this disease the skin of the ear and periauricular tissues is weeping and crusted. There is demonstrated an adjacent focus of infection which is usually a purulent otitis media or mastoiditis or pyoderma. It is presumed that the discharge sensitizes the skin over which it passes.

E. Physical Allergy:⁴⁰ The ear may be affected as part of a general reaction which is produced by exposure to cold, heat, pressure, ultra violet rays or rays from the visible spectrum. The usual reaction is urticaria or erythema. The mechanism may be based on a true antigen-antibody reaction, the antigen being a normally occurring protein which is altered when it is exposed to the physical agent.

V. Traumatic Lesions.

A. Contusions and Lacerations: Following falls or direct blows to the head various sized traumatic lesions may occur. The loss of

tissue may be slight or there may be complete loss of the auricle. Inflammatory reactions of varying degrees of severity may develop.

B. Surgical Incisions: Occasionally, during the postoperative course of a fenestration operation or a radical mastoidectomy some perichondral reaction occurs, and in the rare instance a true perichondritis ensues.

C. Hemorrhages.

1. Hematoma: This may be described as a sudden extravasation of blood between the perichondrium and the cartilage, most often on the anterior surface of the auricle which usually is the result of trauma without laceration. Secondary infection may occur, which frequently results in permanent deformity of the auricle. Hemorrhages into the skin of the external auditory canal are often secondary to skull fractures which involve the osseous meatus.

2. Vesicles and Bullae: Minor hemorrhagic lesions of the skin follow manipulation and treatment of the ear and the use of ear plugs during flight in aircraft.⁴¹ The most frequent findings are hemorrhagic vesicles and various sized bullae.

D. Burns: Such a reaction may be produced by an actual burn of combustible materials, by exposure to heating pads or hot water bottles and by hot liquids such as beverages, greases and oils. The reaction varies from hyperemia to severe third degree burns.

E. Frostbite:⁸ The ear is a favorite site for frostbite. This reaction is characterized by preliminary erythema and turgescence and is followed by blanching and vesiculation. In severe cases gangrene, sloughing and self amputation may occur.

F. Radiation Injury:⁸ Sequelae may occur from any part of the spectrum from that of the gamma rays to those in the visible spectrum.

Roentgen Rays and Radium: The reaction is produced by massive treatment for malignant lesions of the ear or by ill advised continued therapy for benign inflammatory conditions. The initial reaction consists of erythema which may subside and which is often followed in later years by telangiectasis, dryness, atrophy, scarring, keratosis, ulceration and malignant degeneration.

G. Chemical Injury:⁴² The agents in this field which are usually responsible are strong acids or alkalis such as sulfuric acid, nitric acid, carbolic acid, potash, lyes and ammonia water. Since these agents when used in strong concentration will produce reaction on the first

exposure in most normal individuals, the reactions brought about are of a primary irritation and are not based on allergic phenomena. Some therapeutic agents when used in too high a concentration may likewise induce primary irritation.

VI. Senile Changes:⁴³ These changes consist of thinning of the epidermis, loss of elasticity, freckling and dryness. With the dry state, senile pruritis may develop and at times become quite severe. Relatively common also in elderly people is the occurrence of keratoses which may start as localized inflammatory areas over which form adherent scales, grey to tan in color. These may be followed by ulceration which represents a transition from the premalignant to the malignant state.

VII. Vitamin Dyscrasias: There are few conditions which in the light of today's knowledge can be attributed to vitamin dyscrasias. Warranting mention, however, is the fact that when such deficiencies are present the skin suffers.

When the deficiency is that of Vitamin A the skin becomes dry and scaly while small follicular papules form about the follicles. Lack of Vitamin B is the cause of Pellagra, a disease affecting the exposed parts of the body and thus occasionally involving the ears. The scurvy complex with subsequent development of acanthosis and hyperkeratosis is attributed to the lack of Vitamin C.

VIII. Endocrine Dyscrasias.

A. Hypothyroidism: In such a condition the skin may vary from a pale, sallow, greasy state to a cold, thick, dry and scaly condition.

B. Hyperthyroidism: In this condition the skin is warm, moist, thin and translucent.

C. Addison's Disease: The skin is soft and is pigmented to a bronzed or a mulatto-like color. When pigmentations are found on the ear, it is usually part of a general pigmentation of the skin and mucous membranes.

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III

EXPERIMENTAL OCCLUSION OF THE INFERIOR COCHLEAR VEIN

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Our knowledge about the effect of vascular lesions on the labyrinth is limited. In comprehensive reviews of this subject¹ many clinical states are described that are considered to be the result of disturbances in labyrinth circulation, but little factual information is available on which to base these concepts. Vascular lesions are occasionally reported in temporal bone sections, but a definite correlation with functional disturbance during life can rarely be made, except perhaps in some cases of leukemic infiltration and intralabyrinthine hemorrhage.

The general anatomy of the labyrinth blood supply has been known for many years, and has received little attention by investigators for several decades. Recent observations by Smith² on the capillary areas of the cochlea indicate that the capillaries of the stria vascularis have no contractile elements in their walls, and that the vessel of the spiral prominence is independent of the capillaries of the stria vascularis.

These findings are important in developing concepts about the secretion and absorption of the labyrinthine fluids.

On the basis of experiments on models, Agazzi³ has suggested that the independent arteriovenous connections in the spiral ligament may control the volume, velocity and pressure of the blood flow through the capillaries of the stria vascularis.

Bekesy⁴ observed a sudden change of the blood flow in the vessels of the spiral ligament when this area was touched with a fine hair. The diameter of some vessels was increased two or three times, but in some capillaries all movement of the blood cells suddenly stopped. On the other hand, he observed that the streaming velocity of the cells in the capillaries of the spiral osseous lamina appeared to be more resistant to disturbance.

From the Division of Otolaryngology of the University of Chicago.

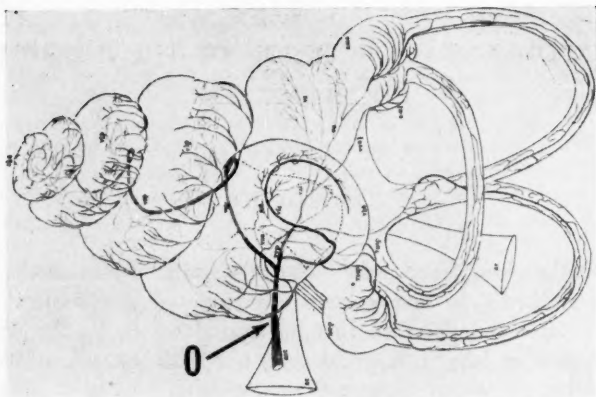


Fig. 1.—Diagram of the venous drainage of the guinea pig labyrinth from Nabeya. The point (O) at which the venous drainage was interrupted in this experiment is indicated by an arrow.

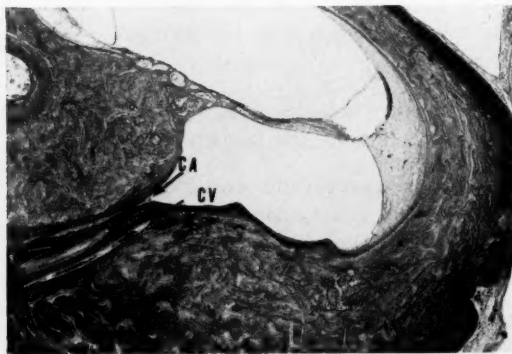


Fig. 2.—Photomicrograph (x 32) of human ear through the separate long, narrow bony channels for the inferior cochlear vein (CV) and for the cochlear aqueduct (CA) near the scala tympani of the basal coil.

All investigators agree that the sole arterial supply to the labyrinth enters through the internal acoustic meatus, but they do not agree on the number of veins draining the labyrinth. In the human labyrinth, three veins are described by Siebenmann.⁵ One vein leaves the labyrinth adjacent to the cochlear aqueduct, another adjacent to the endolymphatic duct, and a third through the internal acoustic meatus.

Nabeya⁶ reports that the last named vessel is not present in his preparations of the human labyrinth. In his extensive investigation on the comparative anatomy of the labyrinth blood supply, Nabeya found differences in the venous drainage in some animals.

He states that while there are two veins draining the labyrinth in the human and the monkey labyrinth, only one is present in the guinea pig, cat and rabbit. In these animals, the entire venous return is carried by the inferior cochlear vein (Fig. 1).

Experimental information is needed about the effect of discrete lesions of the vascular system. In man the vein leaving the basal coil of the cochlea lies in a minute relatively long bony channel, adjacent to but entirely separate from a similar bony channel for the cochlear aqueduct (Fig. 2). The physical nature of the bony channel for this vein would suggest that interference with the venous drainage might occur particularly in this region due to changes in the capsule bone, etc. In the guinea pig, this vein leaves the scala tympani by a separate minute bony canal as in the human (Fig. 3). This canal is surgically accessible from the bulla. The venous drainage of the labyrinth was interrupted at this point and the affect of this lesion studied as described below.

METHOD

Guinea pigs weighing about 300 gm were anesthetized with intraperitoneal nembutal. Some 30 animals were operated upon. The bulla was exposed in the usual manner for acute experiments by resection of part of the mandible. A small opening was made to expose the round window-niche and the adjacent bulge of the basal coil and of ampulla of the posterior vertical canal. The electrical responses of the cochlea to sound were studied before and after the vascular injury was made. A whip of cotton was attached to the bare end of a fine copper wire electrode and placed against the round window membrane. The wire was anchored to the edge of the perforation in the bulla wall by dental cement. The rest of the perforation was closed with cotton, and the wound closed by a few interrupted sutures, leaving the electrode wire protruding. Connections

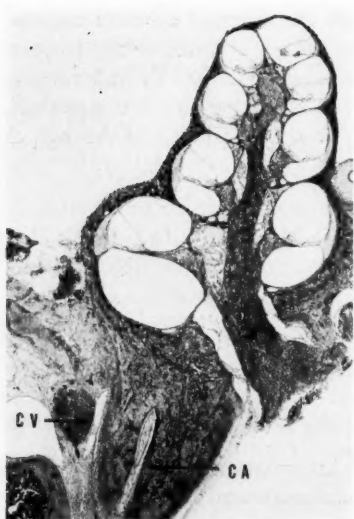


Fig. 3.—Photomicrograph (x 27) of the guinea pig ear showing the separate long, narrow bony channels for the inferior cochlear vein (CV) and for the cochlear aqueduct (CA); this separation extends to the scala tympani of the basal coil, the anatomical relations resembling that in man.



Fig. 4.—Enlarged photograph of the guinea pig cochlea showing the site of surgical interruption of the inferior cochlear vein (O). The termination of this canaliculus (C) and that of the cochlear aqueduct (A) are also seen. The round window niche is seen at R. The turns of the cochlea are numbered. The ampullated end of the posterior vertical canal is at P.

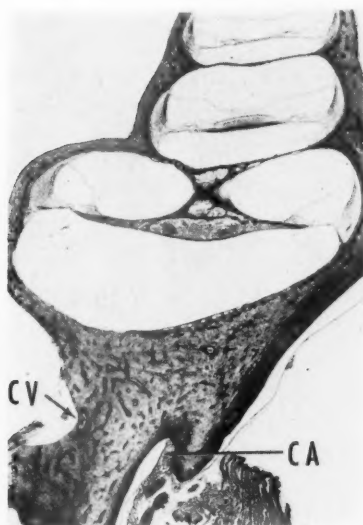


Fig. 5.—Photomicrograph (x 32) showing the site of occlusion of the inferior cochlear vein (CV) outside of the cochlea and separate from the cochlear aqueduct (CA).

to the recording equipment were made with the active electrode and with a ground electrode clipped to the edge of the neck wound. Sound stimuli were introduced into the external auditory canal by a fine plastic tubing leading from a permaflux ear phone. The sound pressure needed to obtain a 25 microvolt response of the microphonic for pure frequencies between 100 and 16,000 cycles per second was recorded. The threshold of the nerve action potential to clicks was now obtained, and the microvolt value of these action potentials was recorded for over-threshold stimuli. Over-threshold responses of the pure tone microphonic was also measured. After a normal response level of this type was obtained, the animal was disconnected from the recording equipment, and the bulla opening again exposed. With a small dental drill the bone overlying the vein was ground away under a dissecting microscope and the blood vessel was identified by the red streak (Fig. 4). The lumen was usually obliterated by bone powder forced into it by the drill, so that free bleeding was rarely seen in this procedure (Fig. 5, 6, 7, 8). Free bleeding could be obtained when the vessel was ruptured closer to the cochlea or over the outer wall of the scala tympani of the basal coil near the round window.



Fig. 6.—Photomicrograph (x 28) showing the site of surgical obstruction of the venous system of the cochlea (CV) outside of the labyrinth and in relation to the cochlear aqueduct (CA) and the ampulla of the post vertical canal (PC). Except for some congestion of the striae vessels (S), there are no signs of damage to the cochlear duct.

After the lesion was made, taking care to prevent disturbance of the electrode anchored nearby and to prevent interference with the conducting mechanism, the animal was again connected to the recording equipment and the same electrical tests carried out as before. Readings were taken at intervals over a two or three hour period. Then the animal was sacrificed and the temporal bones removed for sectioning. Some of the animals were perfused, while some were sacrificed by exanguination with immediate removal of the bones into degassed formalin. The latter method was used in order to prevent any perfusion artefacts from the obstruction produced in the venous outflow from the cochlea. In the chronic experiments, the animals were operated under sterile precautions and without injury to the mandible through a small hole in the bulla over the bulge of the ampullated end of the posterior vertical canal. The right angled dental drill was introduced, and under the dissecting microscope the vein exposed and obliterated. The bulla and wound were closed, and the animals later sacrificed and their temporal bones removed for section with and without making electrical

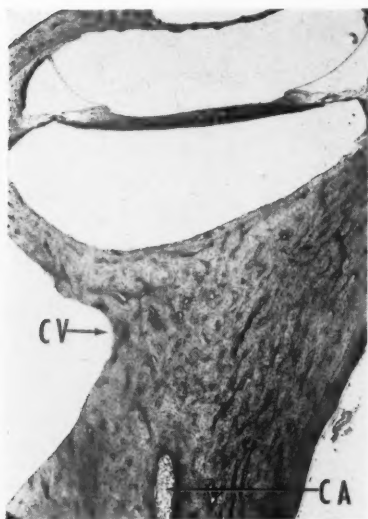


Fig. 7.—Photomicrograph (x 50) showing the inferior cochlear (CV) vein surgically occluded by bone chips—probably explaining why active bleeding from this vessel was not seen. The separate cochlear aqueduct is indicated at (CA).

tests. It was difficult to keep operated animals alive for more than a few days.

FINDINGS

Vestibular Function: If the total venous drainage of the labyrinth of the guinea pig is through this vein, as Nabeya indicated in his report, one would expect not only cochlear but vestibular disturbances. Acute unilateral interruption of the venous flow should produce acute vestibular signs. These were not observed when the lesion was limited to the vein. In some animals, the bone over the amputated end of the posterior vertical canal was accidentally drilled through with leakage of perilymph. In all of these animals, violent nystagmus, body rolling and head torsion were produced. These symptoms usually abated after a few days. The absence of vestibular signs when the vein canaliculi cochleae (Nabeya) was interrupted, suggests that despite the findings of Nabeya there must be other veins leading from the vestibular system of the labyrinth in the guinea pig. Subsequent studies of the microscopic sections of these animals give evidence that veins are indeed present along the endolymphatic duct

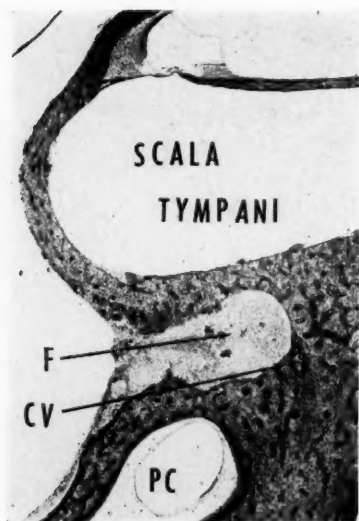


Fig. 8.—Photomicrograph (x 50) of the occluded inferior cochlear vein (CV). The plane of section exaggerates the depth of the surgical field (F). The vein is occluded by bone fragments forced into the minute bony canal by a $\frac{1}{2}$ mm round cutting drill-head used to make the injury. The proximity of the surgical field to the post-vertical semicircular canal and to the scala tympani of the basal coil is apparent.

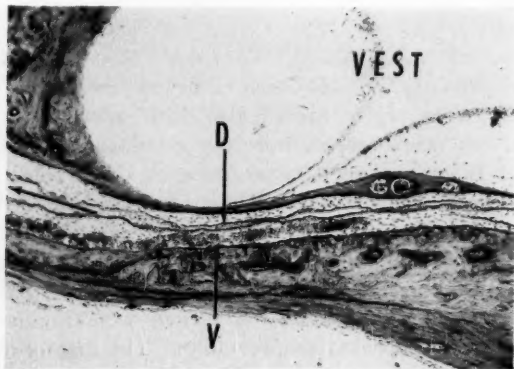


Fig. 9.—Photomicrograph (x 140) of the endolymphatic duct (D) with a large vein (V) lying adjacent to it. This indicates that the venous return from the guinea pig labyrinth is not entirely through the inferior cochlear vein. The vestibule of the labyrinth is indicated by (VEST). The direction of endolymphatic sac is indicated by an arrow in the duct.

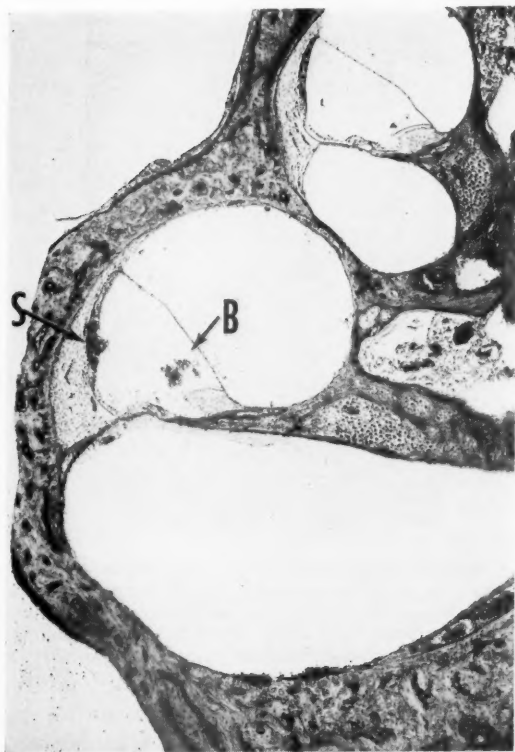


Fig. 10.—Photomicrograph (x 70) showing rupture of the stria vascularis (S) and bleeding (B) into the cochlear duct in an animal whose inferior cochlear vein was surgically occluded. This pathological picture was rarely seen in this experimental series.

and may be related to the venous system of the vestibular labyrinth (Fig. 9). In the acute or chronic experiments, no definite changes in the vestibular end organs could be detected.

Cochlear Function: The behavior of cochlear microphonic and the nerve action potential as recorded from an electrode on the round window membrane did not change after interrupting the vein canaliculi cochleae. No signs of progressive deterioration of the electrical responses were noted during a two or three hour period of observation. A good normal electrical response was obtained in many animals as an indication of the standardized method of recording and testing

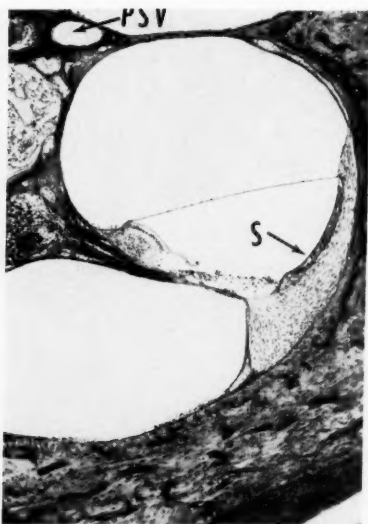


Fig. 11.—Photomicrograph ($\times 115$) of the cochlear duct of a perfused animal showing the empty striae vessels (S) and empty posterior spiral vein (PSV), even though the inferior cochlear vein was surgically occluded. This indicates that some other route of venous outflow from the cochlea, probably along the endolymphatic duct was adequate to allow removal of the blood by the perfusion fluid.

worked out in the laboratory. Rapid alterations in response due to other controlled factors such as anoxia or various interferences with sound conduction indicated that alterations in function could be detected by the electrical responses. A wide range in the acoustic pressure between the threshold and the maximum deliverable stimulus was available for study.

Histological Changes: The site of surgical obliteration of the inferior cochlear vein was clearly defined in the sections. Complete extra labyrinth occlusion of this vein was accomplished without injury to any of the adjacent structures such as the cochlear aqueduct, posterior vertical canal, or scala tympani of the basal coil. The lumen of the vein at the site of operation was usually found obliterated by bone dust and bone chips forced into it by the drill (Fig. 5, 6, 7, 8). No marked changes in the histological details of the inner ear could be determined in most of these cases. Some dilatation of the vessels, as in the stria vascularis (Fig. 6) and an occasional small hemorrhage (Fig. 10), as into the cochlear duct, was observed.

When the animal was successfully perfused there was, in spite of this venous obstruction, complete emptying of the cochlear veins including those of the stria (Fig. 11). This is also suggestive of collateral venous drainage occurring through other vessels.

DISCUSSION

Some idea of the results of acute complete venous obstruction on the function of a sense organ can be obtained from the observations of the ophthalmologist. Klein⁷ points out that venous obstruction may occur in the fundus through external compression, by thrombosis secondary to phlebitis, by primary thrombus formation in blood dyscrasias, by stagnation thrombosis following sudden reduction of arterial blood volume, etc. Complete obstruction produces sudden profound loss of visual function. Hemorrhages and dilated tortuous veins may be seen in the fundus.

Experimentally, Noel⁸ reports that interference of circulation to the retina by external pressure on the globe produces sudden loss of function and loss of electrical responses. Disturbance in the oxygen supply to the retina appears to be the prime operating factor. That the cochlea is extremely sensitive to oxygen supply is demonstrated by the rapid loss of the neural and microphonic responses in anoxia. Acute alteration of the circulation of the cochlear vein should affect the oxygen supply and be revealed in these electrical responses. On the other hand, moderate degrees of slowly developing anoxia in man as found in congenital heart disease and in high altitude conditions do not produce definite changes in auditory function. When the body is exposed to strong linear acceleration in such a direction as to drain blood out of the head into the rest of the body, retinal failure (black out) occurs without cochlear failure. This does not necessarily indicate a difference in sensitivity to anoxia, since the anatomical conditions in the eye may be more conducive to circulatory changes on exposure to these decelerative forces. The higher cortical centers are, however, more sensitive to anoxia than those in the brain stem. The absence of acute, profound functional change in labyrinth function after interrupting the V. canaliculi cochleae suggests that there are other veins draining blood from the labyrinth. This as in man is mostly through the vein of the vestibular aqueduct. The presence of some dilation of the vessels in the stria vascularis and an occasional hemorrhage in some of the acute experiments suggests that some vascular disturbance was produced by this experimental procedure. However, in the animals allowed to live with their vein occluded, no clear cut alteration in the electrical function or histological change could be seen.

SUMMARY

Interruption of the continuity of the inferior cochlear vein in the guinea pig does not produce signs of vestibular or cochlear dysfunction as displayed by nystagmus, head and body torsion, reduction in the amplitude of cochlear microphonics and nerve action potentials.

The venous drainage of the guinea pig labyrinth may not be entirely through the inferior cochlear vein, but may have additional channels through the veins along the vestibular aqueduct as in man.

This collateral venous circulation appears adequate to prevent acute disturbances of labyrinth function on interruption of the inferior cochlear vein. This is also suggested by empty vessels seen in the stria vascularis after perfusion of such a surgical preparation.

Histologically there is evidence of vascular dilation and slight bleeding in the cochlea of a few of the animals with this lesion.

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IV

HEMANGIOMAS OF THE FRONTAL BONE

REPORT OF THREE CASES

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WILLIAM HERBERT SWEET, M.D.

AND

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In a previous communication the extreme rarity of hemangiomas of the frontal bone was emphasized and a short survey of the extant literature was given. Since this communication no similar case has been reported. Caussé called these growths, quoting the experience of Ziberte, angio-osteomes and this name seems to have some justification as it differentiates them from tumors which do not involve the bone, like the cavernous hemangioma found by Salinger on the nasal septum and the forehead. Two other manifestations in this region represented real neoplasms of the bone; a primary hemangioma of the nasal bone, described by Neivert and Bilchick, and a nasofrontal hemangiocavernoma reported by Meda. In differential diagnosis the most similar x-ray picture is given by ossifying fibromas, like the one described by Ball. Only the microscope will decide between the diagnosis of a hemangioma and a fibroma of the bone.

The present report will add three additional instances to the scarce reports on this disease.

REPORT OF CASES

CASE 1.—A white woman (M. B., MGH 740573), aged 54, was referred to us by Dr. Albert Weiser of Fall River, Mass. In her childhood, several enlarged lymph nodes were removed from the right side of the neck (smooth scars). Ten years ago she underwent a hysterectomy with postoperative embolism. In the fall of 1950 she was hospitalized with a condition described by her sur-

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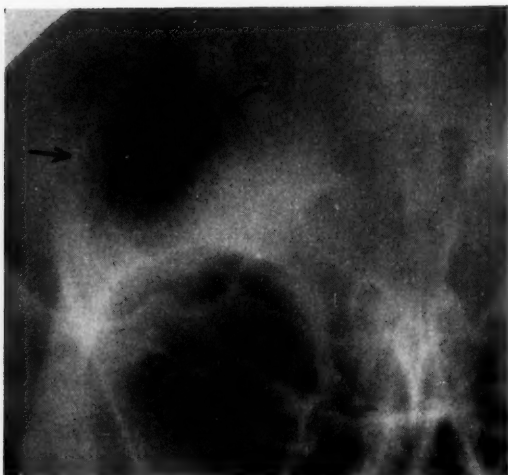


Fig. 1, Case 1.—Anteroposterior x-ray picture.

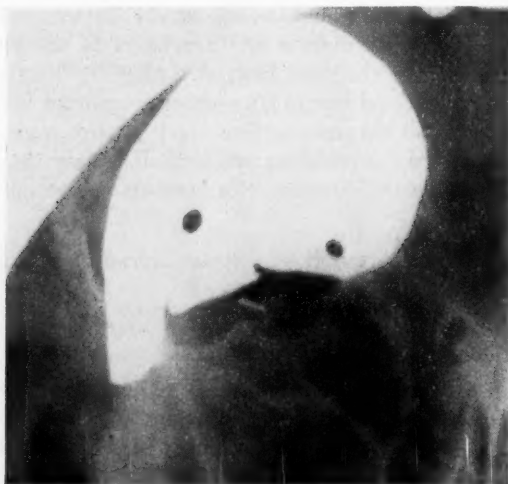


Fig. 2.—Same after operation, with tantalum plate in situ.

geon as a "nervous breakdown" and received insulin and electric shock treatment.

In January, 1951 she felt a slight pain over her right eye and discovered a swelling there with a maximum of pain on pressure over its center. The pain was insignificant, being remittent in character and increasing somewhat with exertion such as long kneeling. She was unable to tell if the swelling had increased in size since she had discovered it.

At her admission on June 28, 1951 a smooth, bone-hard growth the size of a hazelnut, ellipsoid in shape, was found above the center of the right supraorbital ridge under a normal and freely movable skin. In a way it represented a continuation of the medial half of the supraorbital ridge. A furrow could be followed around the growth, deep laterally, shallower medially. The x-ray (Dr. A. S. Macmillan) showed a bony defect of 20 to 15 mm in the right frontal area, just above the orbit with mottled parts of increased density.

On July 2, 1951 under intratracheal anesthesia, a vertical incision was made through the forehead and continued laterally following the hairline. Elevating the periosteum, a purplish raised tumor came into view which was not adherent to it. The entire supraorbital rim and roof of the orbit were exposed, together with the zygomatic process. The zygomatic process was first cut across and a trough was made down through to the dura of the frontal bone. Through this trough, with a motor driven grooving tool, a cut was made completely around the tumor except in the region of the roof of the orbit where space prevented it. An attempt was then made to cut through the supraorbital plate, but, being very difficult to reach, it was merely scored. When the bone was finally loosened, the dura was freed from the undersurface and the supraorbital plate fractured. The bony defect was then closed over with a tantalum plate which was moulded on the spot and held in place with two vitalium screws. The frontal skin was closed by three 3-0 chromic catgut sutures followed by 4-0 dermalon stitches. A pressure dressing was applied.

Crysticillin was given for four postoperative days and on July 5, 1951 after an uneventful recovery, the patient was discharged. When last seen in December, 1951 she had no complaints and the wound was well healed. The position of the tantalum plate was evaluated by x-rays.

The operative specimen measured 3.0 by 2.9 by 1.0 cm, with a weight of 10.3 grams. The approximate extension of the tumor,



Fig. 3, Case 2.—Anteroposterior x-ray picture.

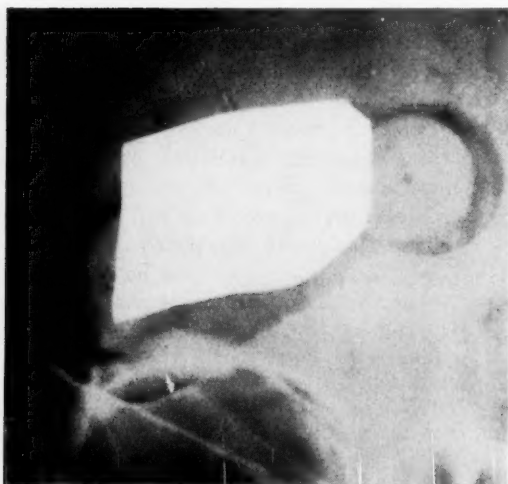


Fig. 4.—Same after operation, with tantalum plate in situ.

which after fixation showed a dark red color contrasting sharply with the normal bone which surrounded it completely, was 1.5 by 2.0 cm, with a thickness of 1.2 cm, bulging through both tabulae. X-ray pictures of the specimen were taken. They showed very clearly on the anteroposterior film the honeycomb structure and on the profile film, with a comparatively smooth internal tabula, the sunray pattern of spicules in the area where the anterior tabula was replaced by growth.

After decalcification, sectioning and staining with hematoxylin-eosin, the following microscopical picture presented itself: The center of the growth was formed by large lakes of red blood cells and coagulated serum. These lakes reached the surface corresponding to the anterior tabula. Some marrow spaces nearer to the normal bone were filled by conglomerates of small vessels within the connective tissue. Obviously these conglomerates were formed by confluence of the large lakes, which were bounded against the bone merely by the thin endothelium characteristic of the sinusoids. The bony lamellae were thinned out giving way to the advancing blood spaces without any visible special mechanism, osteoclasts being rare. Smallest particles of bone were seen within the blood lakes. Osteoblastic activity was quite intensive in the walls of the marrow spaces where sufficient fibrous tissue was left to furnish this kind of cells. Amid this fibrous tissue young and mature myeloid elements were seen. Spicules of bone at the periphery showed an attempt to close the gap, growing with osteoblastic seams from the central side and embedding collagen periosteal fibers from the outside.

CASE 2.—A white woman (E. A. C., MGH 746751), aged 52, noticed about ten years ago a small, non tender mass above the right eye, of about the size of the end of her finger and raised just slightly above the surface of the skin. It was symptomless until three or four months ago when she first noted sharp shooting-like pains in the mass and radiating from it. The pains have gradually become worse over the last three months while the mass, over the last ten years, has gradually become larger. There had been no headache and no other signs whatsoever with the patient's general health good. On admission on Aug. 2, 1951, the electroencephalogram (Dr. Robert S. Schwab) showed a normal record. Skull examination with x-ray (Dr. James McCort) resulted in finding in the right frontal bone, just above the orbital rim, a somewhat oval, 3 cm in diameter, mottled area of radiolucency, with irregular margins. The inner table of the frontal was slightly displaced inward, with no elevation of the outer table present. Both the inner and outer tables in the region of the lesion



Fig. 5, Case 3.—Anteroposterior x-ray picture.

were thinned. There was no evidence of increased vascularity in the surrounding bone. The sella turcica was of average size and smooth in contour, the pineal insufficiently calcified for localization. No other abnormality of the skull was noted. The lesion, which resulted in mottling of the bone with slight evidence of expansion, would seem most likely to represent a hemangioma. The general examination did not reveal any point of interest.

On Aug. 3, 1951 a right frontal craniotomy was performed (Dr. William H. Sweet) in local procaine and intravenous pentothal anesthesia. With the patient lying on her back, and her head and feet elevated somewhat, an incision was made just behind the frontal hairline beginning at the horizontal level about a cm above the zygoma and extending around to the midline at the frontal hairline. It was not possible to expose the obvious tumor without extending the incision down for another $1\frac{1}{2}$ cm below the frontal hairline. Two crown trephine openings were then made in the bone just medial and just lateral to the obvious bony eminence. The cortex of this was so thinned that it was incised with a knife. It was decided that it would be best to try and stay pretty well beyond the lesion. Accordingly two Gigli saw cuts were made, one above and the other below the obvious mass on the skull. The superior saw cut extended just beyond the obvious extent of the tumor, but the inferior saw

cut extended into the lower 2 cm of the extent of the neoplasm. The internal table of the skull was also intact and was not broken down by the tumor. Trabeculae were also still present in the skull in the region where it was infiltrated by tumor. The obvious remnant of tumor immediately above the eyebrow was removed with a rongeur and this additional extension of the removal of another 2-3 mm resulted in entering the right frontal sinus. The mucous membrane of the sinus was not penetrated and was pushed on down into the sinus, then sulfadiazine powder was placed there. The dura was torn slightly in the course of removal of the bony tumor and a flap from the temporal fascia was used to tie over the dural tear. The bone buttons were then replaced after a hole had been drilled in the center of each. An additional hole was drilled in the center of the remaining skull halfway between the two buttons along the superior margin of the area of removal. A thin piece of tantalum sheet was then cut out and three holes were punched in this to correspond with the three holes mentioned previously. The lateral trephine was also in place with an additional hole drilled into the skull and the tantalum plate securely fixed by two buttons onto the skull above. The temporal fascia and pericranium were also used to cover the tantalum plate partly on its external surface. Further closure was secured with interrupted silk to the galea and with continuous fine wire to the skin.

Penicillin was given for five postoperative days and on Aug. 8, 1951, after an uneventful recovery, the patient was discharged. The position of the tantalum plate was controlled by x-ray, which showed on the third postoperative day a cloudy right frontal sinus suggesting the possibility of blood or fluid within this area.

The operative specimen was described (Drs. R. K. Rosales and E. P. Richardson) as a thin plate of bone, about 0.3 cm thick containing a smooth, rounded elevation about 2 by 3 cm in diameter by 1.5 cm in height. On section this area of bone was dark red oozing blood. Microscopically innumerable venous channels were revealed, with an otherwise unremarkable bone. There was no evidence of bone neoplasm. The diagnosis was cavernous hemangioma of the frontal bone.

A further histological analysis showed the largest blood-filled spaces in the center reaching at many points the free surface, while at the periphery where the tumor penetrated between the intact part of the tabulae, the character of the changes in the marrow spaces was capillary. There was osteoblastic and osteoclastic activity roughly corresponding to normal conditions, but osteoclasts were seen only

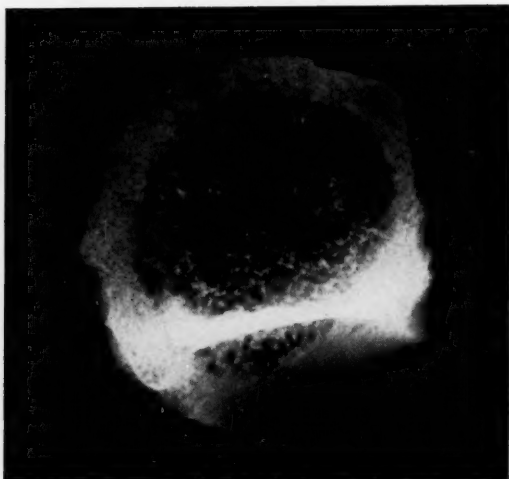


Fig. 6, Case 1.—Operative specimen, anteroposterior x-ray picture. Honeycomb structure.

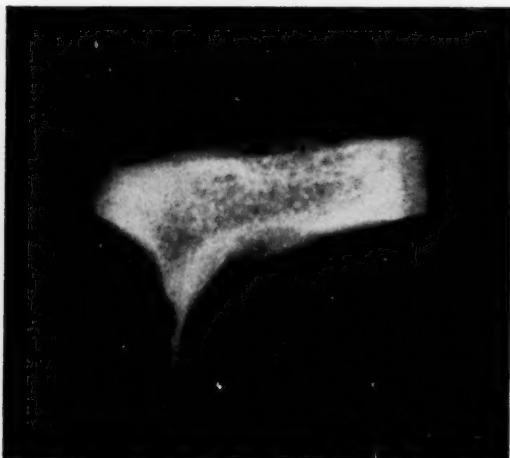


Fig. 7, Case 1.—Operative specimen, profile x-ray picture. Sunray pattern, radiary spicules.

in spaces where some connective tissue was preserved. Corresponding the external surface of the tumor an attempt was noted to enlarge the interlying spicules by osteoblastic and intramembranous ossification.

CASE 3.—A white woman (J. H.), aged 45, presented herself Nov. 29, 1944 with a tender spot in the middle of her forehead on the right side. Examination revealed a slightly elevated subperiosteal swelling about one cm in diameter, about $2\frac{1}{2}$ cm above the orbital rim and over the supraorbital notch. X-ray (Dr. A. S. Macmillan) showed an area of diminished density one cm in diameter just about the external margin of the frontal sinus, with spicules within the area, characteristic of a hemangioma of the frontal. The patient was last seen in June, 1951 and showed no visible extension of the lesion. There have been no subjective symptoms and at present no surgical intervention seems indicated.

COMMENT

The pathogenesis remains in darkness as is the case with every tumor. In these three patients there was no history of trauma which could be listed as an etiological factor. In case of tumors with extension into the frontal sinus, as in case 2, there were precedents where a prolonged inflammatory irritation was considered as equivalent to a physical trauma in activating the neoplastic process (Meda). The same author (Meda) pointed to a possible relationship with the neuro-endocrine equilibrium around the menstrual cycle. A change in the production of histamine-like, vasodilatory substances was demonstrated during this period. The three patients discussed in this report were around the climacteric age and the beginning of the latter can be put down as the earliest stage where the growth appeared. To go farther along this line of speculation, beyond stating these facts, would be unwarranted.

Regarding histogenesis, it is to be recalled here as in the case reported in the previous communication that the area of new growth was in all four cases the tuber frontale. This is the site of the primary ossification center of the frontal, and reversion to the embryonic type of osteogenesis as seen here as one form of repair is easier to understand as starting from this area.

All four cases observed were at the right side of the forehead.

The histogenesis can be followed fairly exactly. While Benjamins adhered to the division of these tumors (angio-osteomas according to his nomenclature) into a capillary and a cavernous form,



Fig. 8.—*Destruction*. Engorged, dilated vessels in Haversian canals. (Case 1) x 100

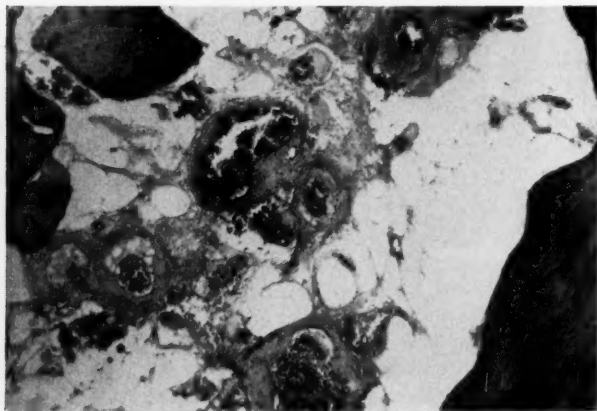


Fig. 9.—*Destruction*. Engorged capillary conglomerates in connective tissue trabeculae of marrow space. (Case 1) x 100

actually both forms exist side by side, the large cavernous lakes being the result of confluence of the capillary conglomerates.

Destruction. In the areas of propagation, where the penetrating neoplasm is prying apart the tabulae, one sees conglomerates of small vessels within the fibrous network of the marrow spaces. Step by step the vessels enlarge and, with destruction of the membranous interstices, form larger blood spaces eventually reaching the limit by filling out an entire space of the marrow spongiosa. The process starts by formation of convolutes in three points: in the vessels of the center of the marrow space; in the small vessels of the connective tissue trabeculae; and in the vessels of the haversian canals. All three seem to undergo the proliferative stimulus simultaneously. While the vessels within the marrow space soon form a large lake, destroy the interstitium and finally even the endothelial lining, the vessels of the haversian canals, with their engorgement, attack the bone from the inside. Direct destruction of the bony network from the walls of the intertrabecular spaces starts only when every trace of connective tissue padding is destroyed and the blood lake reaches the surface of the bone itself. The blood vessels, following the same tendency for expansion, start their work of destruction from both inside and outside. While Erös and Dikansky emphasize the role of osteoclasts in the destruction, our cases give more support to the assumption of Mazzini and Brachetto-Brian who described a "simple atrophy"; at least as much can be said that the lamellae break up and shrink away without following any well distinguishable mechanism, except maybe a rapid decalcification along the youngest lamellae. According to the classification of Benjamins, this is a simple necrotic process more than a lacunary resorption. This grinding process goes on producing smallest spicules, like bone dust, well demonstrable amidst the blood lakes under polarized light, to be finally reabsorbed from here. Osteoclasts, in lacunes, are seen, but far less numerous than in the normal bone parties.

Foreign bodies are known to pass through the endothelial membrane of the intratrabecular spaces, coming from the sinusoids and penetrating through it to the tissue. These small spicules now move in the opposite direction coming from the bone and passing into the sinuses to be reabsorbed within the latter.

As to the speed of the process, some information is given by the osteocytes. They are often well stained in small spicules showing the rapidity of destruction, while in larger necrotic areas with irregular walls they are pale or entirely absent, showing a slower process.

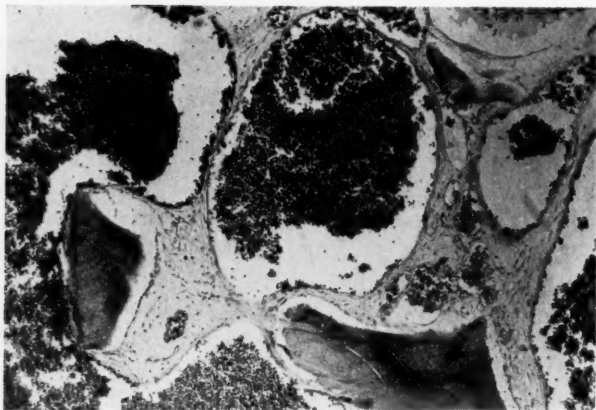


Fig. 10.—*Destruction.* Center of the growth: large blood lakes; remnants of connective tissue with capillary conglomerates; necrosis of bone. (Case 2) x 100

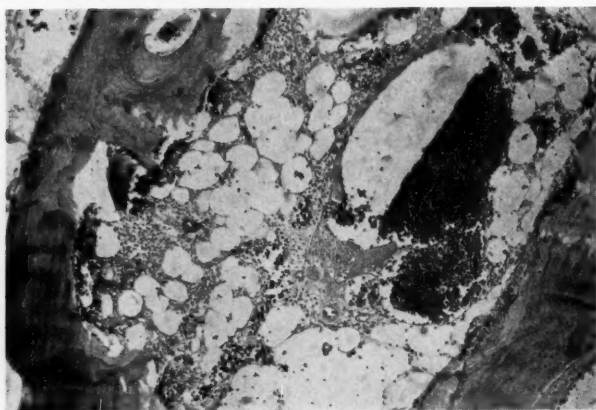


Fig. 11.—*Destruction.* Marrow space with fat tissue and blood lake; in center: conglomerate of small vessels; necrosis of bone. (Case 2) x 100

The cellular elements of the bone marrow found between the cells of the connective tissue are lost with the latter. In the remaining connective tissue partitions, fat tissue and myelocytes were seen, with some denser agglomerations of lymph cells. The endothelial lining seems to be a more resistant kind of tissue, as remnants of it were seen floating between the extravasates after the blood lakes broke through even this last barrier.

Regeneration goes hand in hand with destruction as always in osseous tissue. This is mostly a question of available material to be used in the process of construction. Inside the marrow spaces osteoblastic apposition is going on as long as there are cells of fibrous tissue to be transformed into osteoblasts. In microscopical observation red blood cells along a lamella can be mistaken for a row of osteoblasts, but can be easily identified under higher magnification. The osteoblastic regeneration is going on at the same scale as in normal bone and stops only when necrosis by pressure of the advancing blood spaces destroys the connective tissue. On the outside of the radiary spicules of the surface which form the basis of the sunray pattern in the x-ray picture, the collagenous fibers of the periosteum are used as building material; they are embedded as Sharpey fibers with following ossification. The latter mechanism is responsible for the formation of peculiar caps topping the radiary spicules resulting in a cross section of T-form, these caps standing parallel to the surface and being an attempt to regenerate the destroyed surface of the tabulae. The narrow strips of dura remaining in contact with the bone after removal of the bulk by operation did not show any hyperemia.

One might say that in the course of the development of a similar tumor the dominance of blood spaces simplifies the picture, as normally, according to Maximow, "free cells of the myeloid tissue present an extreme variety of form." All these disappear in the mature part of the tumor which is now formed entirely by blood extravasates and bone debris.

It is probably justified to range these tumors under the "cavernous" variety even when the younger parts present invariably the capillary type, the final product being the area of large spaces in the center, a typically cavernous structure.

Based on this histological picture the age-old question about the primary neof ormation being located in the bone or in the vessels can be answered in favor of a vascular origin. The extraordinary increase in activity in all the vessels as against the normal or less than

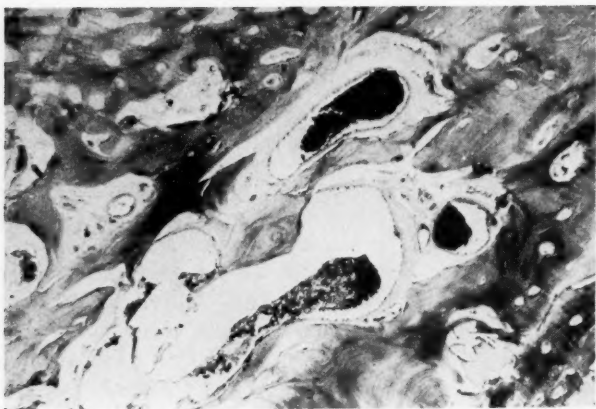


Fig. 12.—*Destruction.* Penetration of angioma (from lower left to upper right) prying apart the intact internal and external tabulae. (Case 2) x 30



Fig. 13.—*Reconstruction.* Bone trabecula showing at the surface intensive osteoblastic activity with deposition of new lamellae; well stained osteocytes inside bone. (Case 1) x 200

normal osteoblastic and osteoclastic activity leaves no doubt about this point. On the other hand an origin cannot be found in the meningeal vessels. The scarce periosteum left on the operative specimens did not show any hyperemia. The tumor is restricted to the medulla and, as there is no reason to assume a general blood dyscrasia, the endothelial lining of the sinusoids must be responsible. Further investigation must try to elucidate this question. We refrained from calling the tumor a primary one as it is known that small herds of a similar affection might exist elsewhere in the skeleton without clinical manifestation.

Symptomatology. Local pressure causes pain above softened parts of the growth which have to be identified with those where the blood lakes reached and destroyed the external tabula. This area can present parchment crepitation. Elsewhere there is only a restricted discomfort and it is unusual that pain should persist as in case 2. In the pre-roentgen era there was no way to diagnose the tumor before removal; but the x-ray showing honeycomb structure in the anteroposterior picture and the sunray disposition of the spicules seen from the profile is so characteristic that practically the only other possibility is to encounter an osteosarcoma. The very slow development leaves enough time to exclude affections like specific inflammations, osteitis fibrosa and others.

Treatment. Operative results are definitive if no parts of the tumor are left behind. If they are a recurrence is probable with a comparatively rapid growth. Independence from the vessel system of the meninges and the periosteum makes the operation an almost bloodless one if one operates well apart from the growth in the healthy bone. Microscopy shows that in the marginal areas, separation of the tabulae goes on in depth, so it is advisable to create a wide area of seemingly healthy bone at the removal. This way the autonomy of the growth will be turned to good use, namely to remove the diseased area without any damage done to the surroundings. In the two operated cases reported here the defect was covered for protection of the exposed dura by tantalum plates.

SUMMARY

Three cases of hemangioma of the frontal bone are reported, a condition which, according to a survey of the literature, seems to be extremely rare. No trauma was found in the history.

Two cases were operated upon while the third did not warrant surgical intervention. Diagnosis was made by x-ray and was fully confirmed by the microscopical examination.

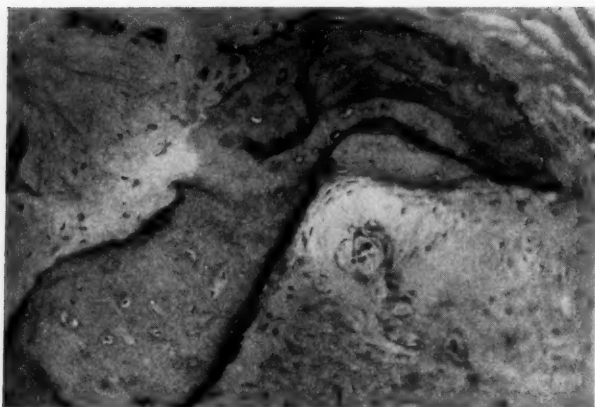


Fig. 14.—*Reconstruction.* Spicule, at surface, in radiary orientation, acquiring, by osteoblastic activity (inside), and ossification of Sharpey-fibers (outside), a cap parallel to the dura (dura in r. upper corner). (Case 1) x 200

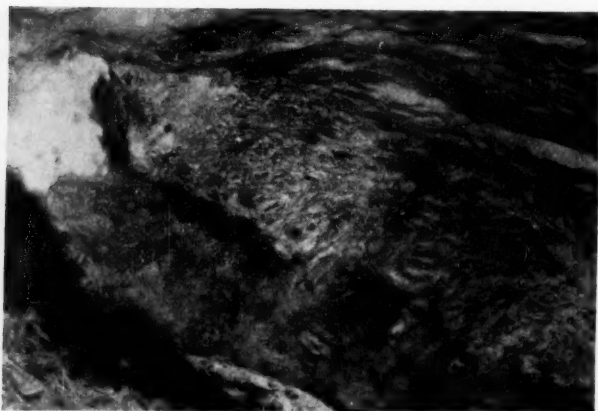


Fig. 15.—*Reconstruction.* Spicule (bottom) under dura (top), growing by embedding of Sharpey-fibers; attempt to reconstruct the external tabula at its original site. (Case 2) x 400

A division into capillary and cavernous angiomas seems unwarranted since the beginning is always by capillary conglomerates forming later blood lakes by confluence. It is probably justified to use in the nomenclature the character of the end-product and speak of cavernous angiomas.

The primary change is seen in the vessels while the bone offers hardly any resistance, though it shows weak attempts of repair, by osteoblastic and intramembranous ossification.

Independence from the vascular system of the galea and the dura results in an almost bloodless operation when a reasonable area of healthy bone is delimited around the lesion, taking into account the penetrating part of the tumor between the tabulae, not visible macroscopically.

Complete removal is the only guaranty against recurrence. It was found useful to cover the exposed dura by tantalum plates.

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V

TREATMENT OF THE TUMORS OF THE INFERIOR ALVEOLUS AND THE MANDIBLE

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Benign and malignant tumors of the inferior alveolus and mandible are uncommon clinical entities, yet their relative importance to the patient is perhaps well beyond their incidence. This is true because they are intimately associated with the functions of eating and speaking, their position lies in the framework for the esthetic component of the lower portion of the face, and their neglect or maltreatment may prove fatal to the patient. Their diagnosis and treatment, therefore, call upon all of the investigative, therapeutic and reconstructive resources of the physician in his efforts to cure, palliate and rehabilitate the patient.

INCIDENCE AND OCCURRENCE

Benign growths of the inferior alveolus and mandible are much more common than malignant tumors in these areas. The vast majority of benign growths are treated and cured by the dentist and oral surgeon.

Malignant tumors of the inferior alveolus and mandible account for only .5% of all of the cancer deaths in the United States. Malignant tumors of these areas occur three times as frequently in men as in women. The rate of occurrence in males has steadily decreased from 1.5 per 100,000 population in 1933 to .9 in 1946. In females, there has been a decrease from .4 in 1933 to .25 in 1946. The reason for this decrease is not known. This type of cancer is most common during the sixth, seventh and eighth decades of life and the sarcomatous varieties are not uncommon in children.

EMBRYOLOGY

A knowledge of the embryology of the inferior alveolus, teeth and mandible is pertinent to an understanding of the variety and position of the different malignant and benign tumors that may originate in these structures. At the end of the fourth week of fetal life the stomodaeum ruptures creating a continuity of the entoderm

of the pharynx with the ectoderm of the first branchial arch (mandibular segment). This segment will gradually develop into the tongue, mandible, lower lip, tooth enamel, lower face and oral covering. There is specialized thickening and movement of the ectodermal covering over the adjacent mesodermal mass, which also forms localized protrusions into the ectodermal covering. These fetal developments progress to the formation of the mandible by mesoderm, teeth by ectoderm for enamel and mesoderm for dentine, alveolus by ectoderm. Comprehension of these embryological facts permits a full conception of the benign and malignant tumor potentialities of these structures.

ETIOLOGY

Intrinsic etiologic factors are obscure. Chronic irritation from poor fitting dental plates, excessive smoking, long standing ulcers and infection, dietary deficiency, chronic irritation and syphilis have all been suggested as possible contributory factors. In many instances, these agents have played a role in both precancerous and cancerous lesions; yet, it is generally felt that they have been overemphasized and that in the vast majority of cases benign and malignant growths appear without a known specific cause. There may be a history of trauma preceding the appearance of a tumor in these areas in rare special instances but a single injury cannot be said to be the causative factor in the origin of these neoplasms. The intrinsic, chemical forces causing the mutation to cancer are unknown.

CLASSIFICATION

- | | |
|--|---|
| I. Benign Lesions of Inferior Alveolus | II. Malignant Tumors of Inferior Alveolus |
| A. Cysts | A. Epidermoid Cancer |
| B. Hypertrophy (simple) | B. Basal Cell Cancer |
| C. Granuloma | C. Adenocarcinoma |
| D. Papilloma | D. Fibrosarcoma |
| E. Leukoplakia | E. Liposarcoma |
| F. Fibroma | F. Lymphosarcoma |
| G. Hemangioma | G. Melanoma |
| H. Lymphangioma | |

III. Benign Lesions of Mandible

A. Cysts

1. Congenital Fissural
2. Dentigerous
3. Periodontal
4. Follicular
5. Radicular
6. Traumatic

B. Tumors (osseous)

1. Osteitis Fibrosa
2. Hyperostosis
3. Exostosis (torus mandibularis)
4. Osteoma
5. Chondroma
6. Benign Giant Cell Tumors
7. Adamantinoma

C. Tumors (connective tissue)

1. Cementoblastoma
2. Fibroma
3. Fibromyxoma
4. Angioma

D. Tumors (odontogenic)

1. Adamantinoma
2. Enameloma
3. Odontoma

IV. Malignant Tumors of Mandible

A. Ectodermal Type

1. Central Adenocystic Basal Cell Epithelioma

2. Central Squamous Cell Cancer

3. Dermoid Cyst

4. Melanoma

5. Adamantinoma

6. Cyndroma

7. Salivary Tissue Type Tumors

B. Mesodermal Type

1. Osteogenic Sarcoma

2. Chondrosarcoma

3. Fibrosarcoma

4. Liposarcoma

5. Malignant Giant Cell

6. Lymphosarcoma

7. Angiosarcoma

8. Angioendothelioma

9. Neurogenic Sarcoma

10. Ewing's Tumor

11. Myeloma

12. Leukemia

V. Metastatic Malignant Tumors of Mandible

A. Carcinoma

1. Lip, Thyroid, Lung, Breast, Prostate, Kidney, Stomach, Melanoma

B. Sarcoma

1. Lymphosarcoma, Myelosarcoma

PATHOLOGY

Benign lesions of the inferior alveolus and mandible are localized, arrested or expanding tissues derived from ectoderm or mesoderm. They may remain stationary in size or expand to huge dimensions, destroying the adjacent tissues by pressure as they grow. They are cured by complete removal.

Malignant tumors of these areas fit into certain patterns of activity depending upon the type, grade, position and size of the neoplasm. The epidermoid carcinomas of the alveolus and associated structures are usually composed of mature and well differentiated cells. The local regional lymph nodes are rarely involved in the early stages of this disease. However, in advanced cases, the submental, submaxillary and cervical lymph nodes are usually invaded by cancer. Metastatic extension into the mediastinum, lungs, liver and brain may occur in the final stages. This type of cancer does not have a tendency to recur locally after proper excision.

Sarcomatous neoplasms of the alveolus and mandible are usually composed of less differentiated types of cells. These tumors may invade the lymphatics and vascular channels early in the development of the disease with spread to the regional lymph nodes and distant organs such as lung, mediastinum, liver and brain. These tumors may recur locally after proper excision.

SYMPTOMATOLOGY, MORBID ANATOMY
AND CLINICAL COURSE

The vast majority of benign lesions of the inferior alveolus and mandible are asymptomatic in their early stages. When symptoms do appear, they are usually the result of pressure of the tumor on adjacent structures or secondary infection. The symptoms are described as a vague ache or pressure sensation in the jaw or localized pain. The principle sign is, of course, the presence of a mass but this may not even be discernible in an intrinsic lesion in the mandible. On the other hand, benign lesions may progress to extensive destruction of the mandible and teeth where spontaneous fracture may occur.

Cancer of the alveolus and soft tissues about the mandible is usually characterized as a reddish, granular ulceration on the horizontal ramus. However, it may appear as a fissured leukoplakia, a smooth ulcer or a chronic infection. It is usually painless and asymptomatic in the early stages. As it progresses beyond two centimeters in size, the ulceration becomes deeper and a local cellulitis and aden-

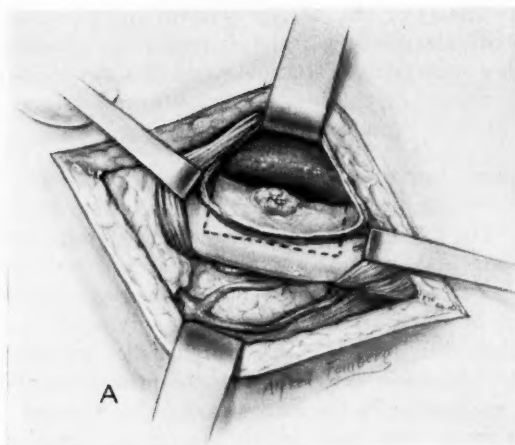


Fig. 1.—Segmental resection of alveolus and mandible for early cancer of the alveolus.

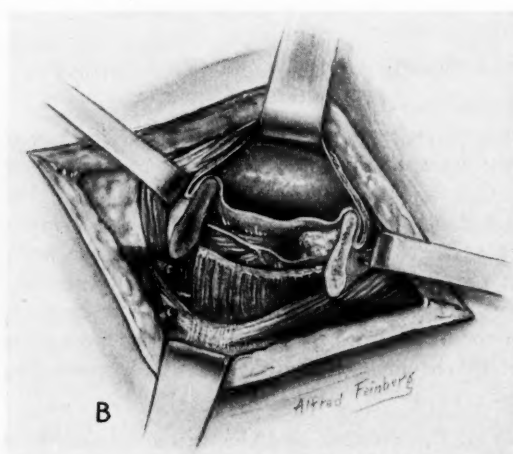


Fig. 2.—Sectional resection of mandible and alveolar with suprahyoid contents in continuity for cancer of alveolus or bone without metastasis.

itis appears. This element of infection calls the patient's attention to a sore or tender spot in the mouth and that frequently directs attention to the tumor. The tumor may metastasize to the neck before the patient is aware of the primary lesion and he presents himself for examination because of this lump in his neck. Approximately 50% of the patients with this disease reporting for treatment present evidence of a large primary tumor and also metastatic involvement of the neck glands. In the advanced stages, these carcinomas ulcerate beyond the mandible and involve the floor of the mouth, tongue, palate, cheek. Severe fifth nerve pain is often present at this time with inability to take food properly and malnutrition.

The only early clinical sign of primary malignant tumors in the jaw bone is tumefaction. There may be the suggestion of a dull ache in the jaw and the teeth may become loose and fall out. As these tumors increase in size, they destroy the bone and eventually may ulcerate into the mouth or externally into the neck and face. Fungation may be rapid at this point and the jaw may fracture spontaneously. Metastases are usually evident at this stage of the disease.

DIAGNOSIS

Nothing challenges the importance or gravity of a prompt and accurate diagnosis of cancer in the mouth. Undue procrastination and the unwise attitude of "waiting to see what happens" may cost the patient his life. Benign lesions should be accurately separated from the malignant ones. The diagnosis is accomplished by clinical examination, stereoscopic roentgen study of the mandible and biopsy. Of these three methods, biopsy is the most important. The clinical diagnosis of all benign lesions by examination and roentgenography should be checked by microscopic examination of the surgical specimen after removal.

Every suspicious lesion should be biopsied immediately. Any lesion which persists more than two weeks should be biopsied. The history of the lesion as related by the patient is significant but should not cause delay in establishing a microscopic diagnosis which, in the last analysis, is the only final one. The usual technique of biopsy is by punch forceps with or without local anesthesia. When the tumor is confined to the bone, aspiration biopsy or the direct surgical approach through the cortex of the bone is warranted. Needle biopsy, frozen section and fibrous contact biopsies may be used.

Stereoscopic examination of the mandible demonstrates the type and extent of bone destruction and new growth. Benign tumors of the mandible show up as a rule as solid, encapsulated, bony masses or cysts containing a well-defined capsule or localized areas of dis-

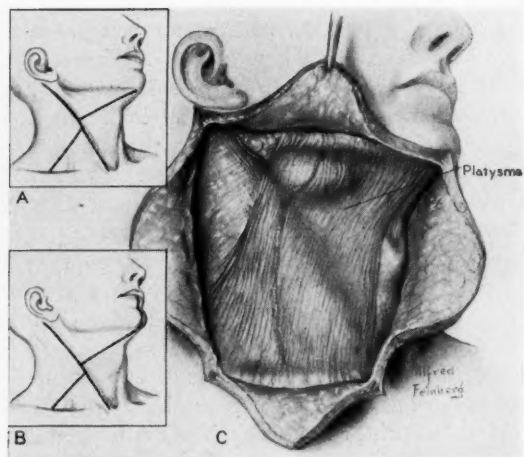


Fig. 3.—Planning neck and lip incisions for removal of metastatic disease of the neck in continuity with jaw bone.

solution and regeneration of bone. Occasionally, benign tumor formation may resemble malignant growth.

In early malignant tumors of the alveolus and periosteum, there is usually no evident bone destruction. In advanced cancers of the alveolus and bone, the bone is destroyed and has a moth-eaten appearance without any significant tendency to osteogenesis. The infiltration is primarily destructive in character beginning at the cortex and extending into the cancellous area.

In contrast, osteogenic sarcoma progresses from an internal position toward the cortex and soft tissues. Roentgenographically, there is evidence of osteolytic and osteogenic activity. Fibrosarcoma presents a roughened eaten-out outline. Chondrosarcoma shows blotchy areas of calcification and ossification associated with a thick shell. Ewing's tumor presents layered, irregular shadows of bone destruction. Myeloma is characterized by areas of reduced density with essentially normal appearing adjacent bone. Adamantinoma destroys normal bone and replaces it with multiple cystic bone spaces surrounded with a bony shell.

The differential diagnosis clinically is with Vincent's infection, chronic ulceration, trauma, osteomyelitis, gumma and benign growths.

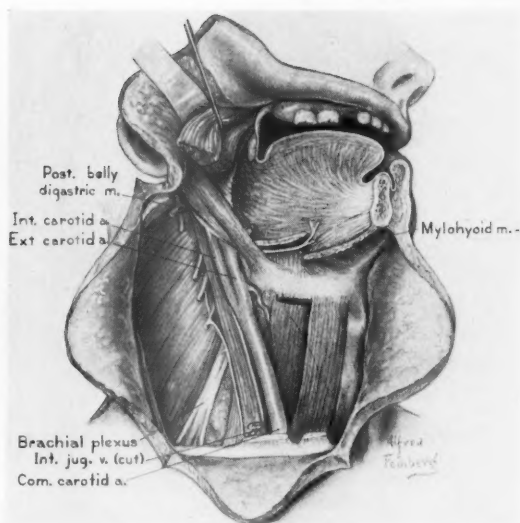


Fig. 4.—Resection of half tongue, jaw bone, floor of mouth and neck in continuity for cancer of jaw bone and tongue with metastasis to neck.

Premalignant lesions such as leukoplakia, chronic ulceration, granuloma, papillomata and fibromata should be recognized at this time and treated adequately as prophylaxis against cancer.

SURGICAL TREATMENT

An accurate preoperative estimation of the character and extent of the tumor assists in planning the excisional and reconstructive phases of the surgical technique.

Surgical treatment is the treatment of choice for all benign tumors in the mandible. Benign tumors are, as a rule, cured by less radical procedures than the malignant tumors. Cysts are curetted free of their contents and lining membranes and packed open. Electrical or chemical cautery may be applied to the surfaces and margins of these cysts. Small benign bony or soft tissue tumors are enucleated and the base treated with electric or chemical cautery. Occasionally, a benign cyst or solid tumor will have weakened the wall of the mandible as a result of its growth to such a degree that resection of the full thickness of the mandible at this site is indicated. This deficiency is immediately corrected with a free bone graft held in position by internal fixation.

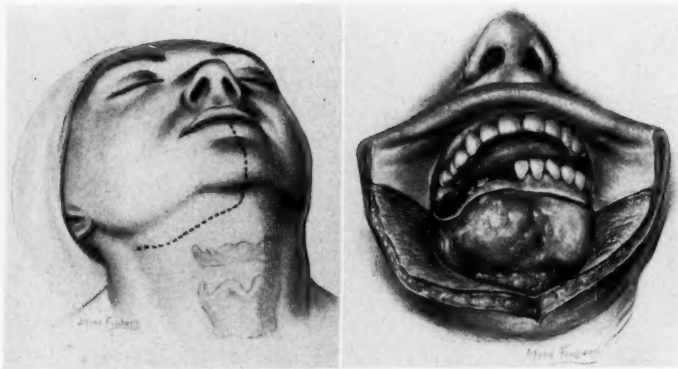


Fig. 5.—(L) Release of lower lip for more adequate exposure of jaw bone. (R) Release of entire lower lip and cheeks for adequate approach to mandible in cases of extensive cancer.

The basic philosophy of all surgical procedures in the treatment of tumors is the total removal of the new growth, and the most complete reparative and reconstructive procedure possible at that time. The phrase "total removal" has no greater significance than in the treatment of cancer. This is accomplished by a wise and careful preoperative evaluation of the patient and his tumor, and then a bold, radical resection of not only the gross and apparent malignant process but also a wide margin of normal appearing tissue about this neoplasm.

In the approach to these surgical problems certain prophylactic and precautionary measures have been found essential. They reduce the mortality and morbidity and assist in the cure.

The routine ligation of one or both external carotid arteries in the extensive neck and jaw resections aids in hemostasis and facilitates the operation. However, it is preferred not to perform an arterial ligation if a bone graft is done in order that the recipient site may retain its blood supply. External carotid artery ligation is not necessary in limited surgical procedures about the jaw and alveolus.

Endotracheal inhalation anesthesia or pentothal sodium anesthesia plus supplemental oxygen through an endotracheal tube is preferred.

The pharynx should be snugly packed with gauze packing to prevent the aspiration of blood.

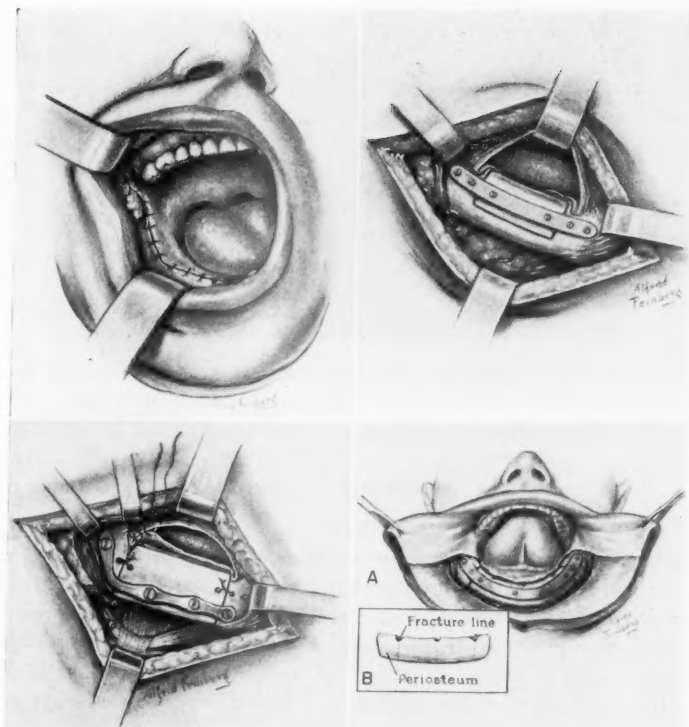


Fig. 6.—(upper left) Intraoral approach for limited cancer of alveolus, small adamantinoma and benign tumors.

Fig. 7.—(upper right) Onlay iliac bone graft fixed in position of mandible by special metal plate and screws.

Fig. 8.—(lower left) Osteoperiosteal iliac bone graft in mandible fixed in position with special modelled plate and screws.

Fig. 9.—(lower right) Modelled rib graft held in position with special plate and screws for reconstruction of the mental process.

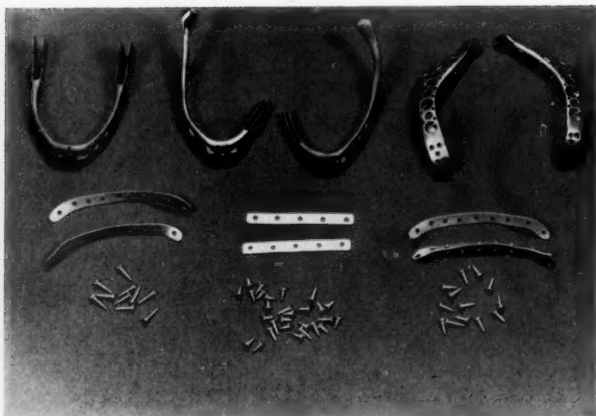


Fig. 10.—Various sizes and shapes of cast vitallium prosthesis for mandibular restoration.

Adequate whole blood should be available for transfusions during the operation.

Prophylactic tracheotomy is the safeguard against asphyxiation and should receive serious consideration for all patients in whom the continuity of the mandible is disturbed and the procedure had included manipulation of the floor of the mouth and neck. When endotracheal anesthesia is employed, the tracheotomy may be done at the conclusion of the operation. When pentothal sodium anesthesia is used it may be done at the beginning of the operation. Tracheotomy is not indicated in minor procedures on the alveolus and mandible, and usually not indicated in Classes 1 and 2. Decannulization may be carried out in from three to 14 days.

Installation of an endonasal feeding tube permits maintenance of a normal dietary intake and electrolyte balance.

Oral hygiene should be diligently applied for any radical operation in the mouth. This is particularly true when grafting is anticipated. This includes treatment to infected gums, cleaning and filling of carious teeth and extractions of abscessed teeth.

Energetic use of antibiotics and chemotherapeutic agents is most helpful in preventing and controlling infection.

Adequate drainage of the wound is necessary.

A large supportive dressing assists in healing.

Intelligent medical care of all medical aspects of the case is often the difference between success and failure.

Malignant tumors of the alveolus and mandible usually require more extensive types of surgery than other conditions in these areas. This is particularly true in far advanced cases with metastatic disease in the mouth and neck. Classification of the type and extension of the disease establishes the criteria for the technique to be employed in the excisional phase.

	CRITERIA	OPERATION
Class 1	Early low grade cancer limited to the alveolus (no evidence of metastatic disease).	1. Segmental resection of alveolus and mandible
Class 2	Cancer of the alveolus or mandible or both (limited and no evidence of metastatic disease).	2. Sectional resection of alveolus and mandible and suprahyoid dissection in continuity.
Class 3	Cancer of alveolus and mandible with metastatic disease in the neck.	3. Sectional resection of alveolus and mandible and lateral neck dissection in continuity.
Class 4	Extensive cancer of alveolus and mandible with involvement of floor of the mouth, tongue and neck.	4. Resection of half or more of the alveolus and mandible with a segment of tongue and floor of the mouth and lateral neck dissection in continuity.
Class 5	Sarcoma of the mandible.	5. Treated as cancer according to its extent of involvement.
Class 6	Adamantinoma.	6. Segmental or sectional resection of the mandible according to size of tumor.

Class 1. Segmental resection of the mandible is reserved for extremely early cases of carcinoma of the alveolus which have invaded the periosteum but not the bone. An intra-oral approach is usually



Fig. 11.—Resection of entire mandible for large adamantinoma or cystic tumor.

satisfactory. The technique consists of removing the involved alveolus and periosteum with a wide margin of healthy tissue along with the underlying segment of bone in continuity. The rim of bone on the inferior aspect of the mandible is preserved, thus maintaining the continuity of the arch. The wound edges may be immediately directly approximated over the bone (Fig. 1).

Class 2. Sectional resection of the mandible and suprahyoid dissection in continuity is indicated in cases where the carcinoma has involved the alveolus and a limited area of bone. There should be no clinical evidence of metastatic disease in the lymphatic drainage bed. This operation is carried out through a submaxillary incision, the involved area of the mandible is totally excised along with the alveolus and mucous membrane surfaces in continuity with the suprahyoid structure on that side (Fig. 2).

Class 3. Sectional resection of the alveolus and mandible with radical neck dissection in continuity is carried out in all instances of limited carcinoma of the alveolus and mandible with any evidence whatsoever of metastatic cancer in the neck. Block dissection of the neck is accomplished up to the mandible and after appropriate splitting of the lower lip and release of the lower lip flap the involved sections of the alveolus and mandible are removed in continuity with the lateral neck mass. In Class 2 a prophylactic suprahyoid dissection is performed when there is no clinical evidence of metastatic disease. However, once any evidence of metastatic disease is apparent, even a single suspicious node in the submaxillary space, a radical

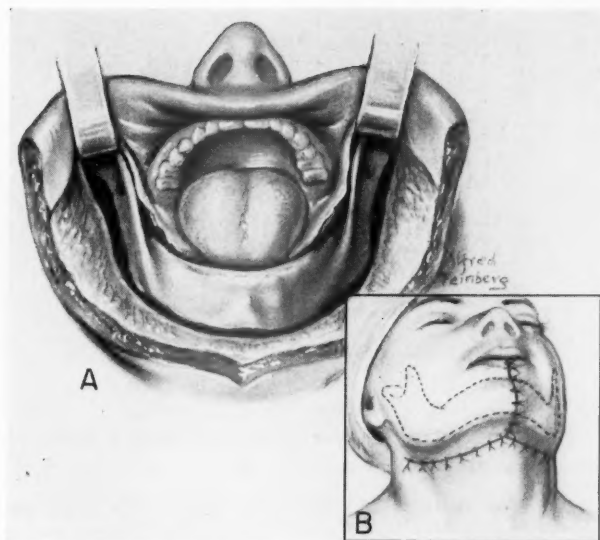


Fig. 12.—(1) Lip and neck incisions for proper mandibular exposure.
(2) Implantation of ice-box homologous mandible for total reconstruction.

lateral neck dissection is recommended in continuity with the primary lesion.

Class 4. Resection of half or more of the mandible, plus the floor of the mouth, a section of the tongue and palate along with a unilateral or bilateral radical neck dissection is indicated in all cases where the carcinoma of the mandible and alveolus is extensive and has transgressed into the floor of the mouth, tongue or palate, and where there is any evidence of metastatic disease in the neck. The technique is carried out through the same approach as described in Class 3. After the lateral neck contents are released and the lower lip flap retracted, the mandible, floor of the mouth and tongue segments are freed along with the suprahyoid space contents and after disarticulation of the head of the mandible the entire mass is freed from the tip of the mastoid process (Figs. 3 and 4).

Class 5. Sarcomas of the mandible are handled in a similar but somewhat more aggressive manner than the carcinomas. Generous resection of the bone and associated soft tissues are indicated with particular care to avoid fracturing the weakened segment of mandible (Fig. 5).

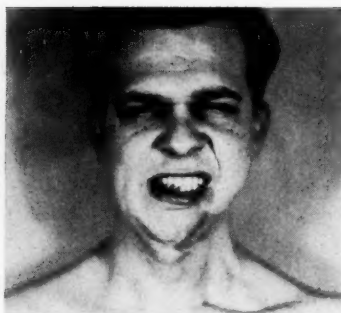


Fig. 13.—Mandibular prosthesis in position.

If regional metastatic disease is present then a radical lateral neck dissection is also indicated.

Class 6. Adamantinoma (ameloblastoma) may grow to huge proportions (8 pounds 6 oz. Conley-Pack), but rarely metastasize to the regional lymph nodes or distant organs. They are encapsulated. Resection of the involved area plus normal mandible at the extremities of the tumor usually effects a cure. If the adamantinoma is small in size, the intra-oral approach may be used (Fig. 6) but if there is any question regarding adequate exposure a submaxillary or lower lip splitting incision is performed. Curettage of these tumors has been discredited.

REPARATIVE PHASES

All of these wounds are repaired immediately. Adequate drainage at the dependent portion of the wound is maintained and a supportive dressing is applied. Prophylactic tracheotomy to maintain adequate airway, pharyngeal packing to prevent the aspiration of blood, adequate supportive treatment by infusions, blood transfusions and Levin tube feeding and good medical management keep the operative risk in these cases at a minimum and shorten the morbidity.

In the mouth mucous membrane surfaces are directly approximated when possible. In the more extensive resections the cut edge of the tongue is sutured to the cut edge of the buccal mucosa in repairing the floor of the mouth. Externally on the neck, chin and lip the skin is directly approximated with interrupted fine silk sutures. Areas which have lost large elements of skin covering are repaired by skin flaps or free skin grafts.



Fig. 14.—Mandibular prosthesis in position.

RECONSTRUCTIVE PHASES

Reconstructive surgery may be performed immediately in many instances, depending upon the warranty. In other instances reconstructive surgery is delayed and performed as a secondary procedure or delayed indefinitely. In many of these cases oral prostheses assist remarkably in the rehabilitation of the patient. These reconstructive and rehabilitative procedures may be classified as follows:

1. Onlay graft and bone chips.
2. Bone graft from iliac crest (autogenous).
3. Rib grafts (autogenous).
4. Inert implants (metal and plastic bars and molded mandibular segments).
5. Icebox bone (homologous).
6. Oral prosthesis.

1) If the segmental resection of the alveolus and a portion of the mandible have weakened the continuity of the mandibular arch beyond its functional limits, this defect should be corrected immediately by either the implantation of bone chips or a small inlay bone graft taken from the iliac crest. These grafts are fixed internally with special plates, screws or wires (Fig. 7). The jaw should be partially or totally immobilized for four to six weeks.

2) In sectional resection of the mandible and suprahyoid dissection in continuity, the restoration of the mandibular arch is accomplished by the transplantation of a modeled bone graft from the iliac crest. The horizontal ramus is involved in the majority of instances. This graft is shaped to match the exact size of the section of bone removed. It is maintained in position by internal fixation with specially adapted plates and screws. The mucous membrane of the mouth is carefully sewed over this graft and a drain is placed at the dependent portion of the wound for a week. It has not been necessary to remove the metallic plate or screws at a later date. This technique is considered superior to wiring of the bone graft or intermaxillary wiring or external fixation by use of the Roger-Anderson or (Stader) apparatus. This technique permits the patient to begin ingestion of a soft and liquid diet by mouth on the tenth day post-operative (Fig. 8).

3) When the mental process of the mandible has been removed or when an unusually long section of mandible is to be reconstructed, rib grafts are preferable. These sections of bone grafts have wedges taken from their concave side in order to permit further modeling and shaping. One or two ribs may be used to accomplish the necessary transformation in contour and function. They are maintained in position by internal fixation as previously illustrated (Fig. 9). In some instances in bone grafting it is desirable to create a glossal and alveolar sulcus by inlay grafting after the primary reconstruction is well healed.

4) Inert implants such as vitallium, steel, tantalum and plastic compounds are used when the probabilities of having a successful "take" of a bone graft are very low. These instances apply to cases that have had excessive amounts of irradiation, where there is ulceration and infection, or where there is extensive loss of tissue (Fig. 10). These implants consist of a section of previously modeled metallic or plastic prostheses to fill deficiencies of the whole mandible, half of the mandible and other fractions of the mandible. If they are tolerated by the tissues they remain as a permanent component of the jaw. If these inert implants are not tolerated or are inadequate in size, shape and strength an iliac or rib bone graft may be substituted in their position at a later date.

5) Icebox bone (homologous) is of service when very extensive or total reconstruction of the mandible is contemplated. Neither it nor any inert compound should replace the patient's own bone for grafting purposes unless there are definite contraindications for the autogenous graft. This particular technique is usually limit-

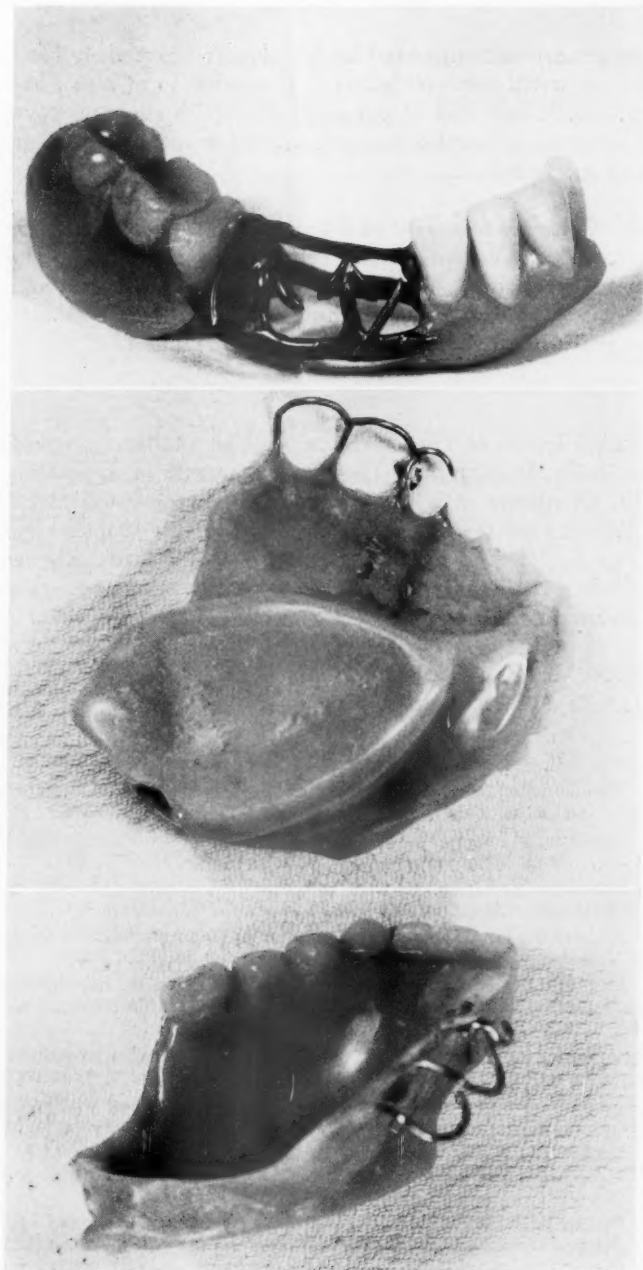


Fig. 15.—(top) Mandibular prosthesis. (center) Maxillary prosthesis. (lower) Maxillary prosthesis.

ed to large adamantinomas and benign tumors where there has been no previous irradiation and where it is possible to salvage adequate mucosa, muscle and skin to not only accomplish adequate coverage of the icebox bone but also to attach the important muscles of mastication (Figs. 11 and 12).

6) Oral prostheses applied to the mandible are of great assistance in improving facial contour and creating more satisfactory biting and chewing surfaces. When they are constructed properly and the patient has accepted them, a definite step toward the rehabilitation of that individual has been made (Figs. 13, 14 and 15).

PROGNOSIS

Benign lesions of the lower jaw have an excellent prognosis as to cure and rehabilitation. There is a cure rate of approximately 30% in all comers with carcinoma of the alveolus and mandible. Early limited cancers in these cases have a prognosis of approximately 70% cured. Many of these patients with cancer are readily rehabilitated when the destructive and reconstructive operations are combined in one procedure.

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VI

BRONCHOSCOPIC REMOVAL OF A FOREIGN BODY WITH THE AID OF TRIANGULATION ROENTGENOSCOPY

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AND

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Triangulation roentgenoscopy^{1, 2} was devised by one of us, W. E. Roberts, as a guide in the removal of radiopaque foreign bodies. We have used the triangulation fluoroscope exclusively for the past 15 years. This method, employing a single fluoroscopic screen, is extremely easy to use in contrast to the biplane instrument where constant shifting from one plane to another is necessary. In triangulation all dimensions to the right, to the left, above or below the foreign body are seen at a glance on the single screen by the roentgenoscopist as easily as images are seen in conventional roentgenoscopy.

The triangulation roentgenoscope reduced to its simplest explanation consists of two tubes under the table on a single carriage so that the central ray of either tube may be adjusted to any desired angle (cross fire for triangulation). Each tube has its own filament control thus making it a simple procedure to keep the amperage on each tube equalized. This does not interfere with conventional roentgenoscopy as the control panel is so wired as to permit the use of one or both tubes. The shutter opening must be of special design (S & H X-ray Company, Charlotte, N. C.), needing a larger opening.

Having two tubes activated simultaneously and with their central rays intersecting, two images of the foreign body will be produced on the fluoroscopic screen at all times. Then when the forceps or magnet are introduced into the field, there will be two images of the forceps or magnet. Now, if the forcep's shadows are to the right or left of the foreign body shadows, it is obvious that the forceps are in the wrong plane. If the forceps or magnet are introduced into a bronchus posterior to the foreign body, the images of the forceps or

From the Charlotte Eye, Ear and Throat Hospital.

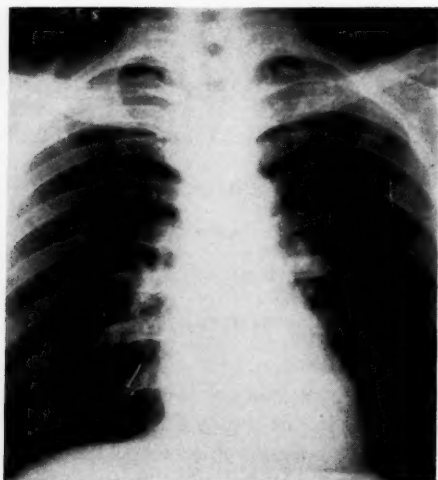


Fig. 1.—Postero-anterior roentgenogram showing an escutcheon nail in the posterior basal segment of the right lower lobe bronchus.



Fig. 2.—Lateral roentgenogram of the preceding.

magnet will be farther apart than the images of the foreign body because the triangles formed by the intersecting rays both to the foreign body and magnet are unequal. Introduction of the forceps or magnet into a bronchus anterior to the one containing the foreign body will be revealed by the forceps or magnet shadows being closer together than those of the foreign body for the same reason as above. When the forceps or magnet are introduced into the proper plane (the same plane as the foreign body), the distance between the foreign body shadows and the forceps or magnet shadows will be the same. This is true because the triangles formed by the intersecting rays both to the foreign body and the forceps or magnet are identical in size.

No one dimension need be considered separately. All variations in position of the forceps or magnet in relation to the foreign body can be seen at a glance. No shifting from the vertical plane to the horizontal plane is needed as in biplane roentgenoscopy. The roentgenoscopist has all dimensions at all times on a single fluoroscopic screen continuously under his observation.

Triangulation roentgenoscopy in our experience has been a valuable adjunct to forceps extraction of foreign bodies beyond endoscopic vision. Since the Alnico magnet has been added to our armamentarium, the extraction of ferro-magnetic foreign bodies from the segmental subdivisions of the bronchial tree has been facilitated.^{3, 4}

The same problems which confront us today have in the past been solved satisfactorily by forceps extraction.⁵ However, if we are dealing with a magnetic object in the smaller bronchioles, the employment of the magnet is less traumatic and more maneuverable than rigid forceps.

REPORT OF A CASE

The following case illustrates the absolute necessity of cooperation between the bronchoscopist and the roentgenoscopist in the final successful solution of the problem.

J. C. M., a white male, aged 37, was referred to us on Nov. 2, 1951. While attempting to weather strip his house, the patient accidentally aspirated a small weather stripping nail which he had held in his mouth. The physical findings were essentially negative. Roentgenograms brought along by the patient revealed the foreign body to be a small nail located in the right lung probably beyond endoscopic vision (Figs. 1 and 2). A duplicate of the foreign body in question revealed this to be a magnetic escutcheon nail measuring 1.7 cm in length.



Fig. 3.—Magnet shadows to the right of the nail shadows (film made during triangulation roentgenoscopy).



Fig. 4.—Magnet shadows to the left of the nail shadows (film made during actual operation of combined bronchoscopy and triangulation roentgenoscopy).

On Nov. 3, 1951, after preliminary sedation, the airway was prepared with topical cocaine anesthesia. Bronchoscopy was then done and the nail found to be beyond endoscopic vision. In other words, the nail was probably in a segmental subdivision of the right middle or lower lobe bronchus. With the aid of triangulation roentgenoscopy, an Equen bronchoscopic magnet (3 mm diameter attached to a woven stem) was inserted into the various orifices of both the middle and lower lobe bronchi by the trial and error method. Figure 3 illustrates that the magnet was too far to the right of the nail. Similarly, Fig. 4 illustrates that the magnet was too far to the left of the foreign body. Work was then discontinued because we felt that the patient had had enough manipulation for one day.

On Nov. 5, 1951 the entire procedure was repeated, but we were unable to make contact with the nail.

On Nov. 15, 1951 bronchoscopy was again done under local anesthesia. A 7 x 40 standard Jackson bronchoscope was introduced without the use of a laryngoscope. The middle lobe orifice was first brought into view. Using a Holinger vertebrated tip magnet⁶ the lateral division of the middle lobe was entered, but the roentgenoscopist said the magnet was too far to the right. The medial segment of the middle lobe was then entered, and the roentgenoscopist said the magnet was too far to the left. From these observations an impression that the foreign body might be in the middle lobe was discarded.

The bronchoscope was advanced, exposing the subdivisions of the lower lobe. The vertebrated tip magnet was passed into the superior segment, the anterior basal segment, the lateral basal segment and the medial basal segment.⁷ In none of these were we near the foreign body. The magnet was passed into the posterior basal segment and the roentgenoscopist said it was nearer to the foreign body than heretofore.

On closer inspection of the posterior basal segment, a small segmental orifice was seen anteriorly. This would admit neither forceps nor the Holinger vertebrated tip magnet. After some difficulty, the 3 mm Equen Alnico magnet was passed into this subdivision. At this point the roentgenoscopist said that the magnet was in the correct subdivision. Advancing the magnet, contact was established (Fig. 5). Three attempts to extract the nail resulted in the magnet's slipping off the foreign body. The magnet was again advanced to the nail and this time the patient's head was turned to the left in order to better align the bronchus. The bronchoscopist (A. A. D.) was helped by also observing through the fluoroscopic screen. Upon

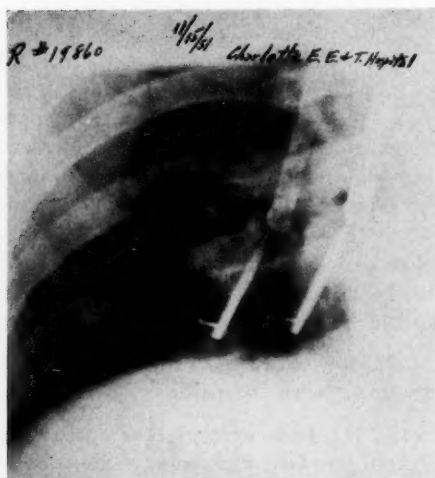


Fig. 5.—Magnet in the proper plane because the distance between the nail shadows and the magnet shadows is the same. Although contact was certain, the nail could not be "pulled around the corner."

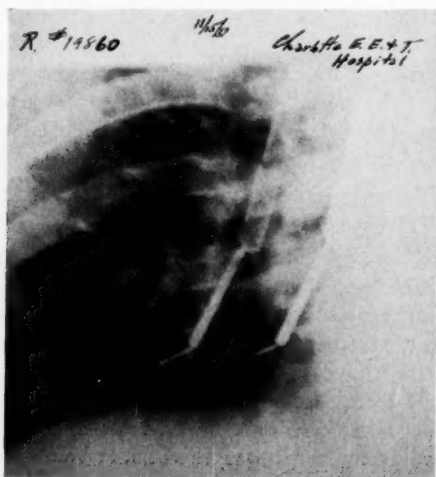


Fig. 6.—After turning the patient's head to the left (both the roentgenoscopist and bronchoscopist watching the screen), the bronchus was brought into better alignment. Magnet and attached nail were then extracted with ease.

traction on the magnet, the nail came with it (Fig. 6). The magnet and attached nail were then extracted through the bronchoscope. The bronchoscope was withdrawn and the patient returned to the room in good condition. The total operating time was approximately 20 minutes. The patient was dismissed the next day and has had no further difficulty.

SUMMARY

Triangulation roentgenoscopy, as developed in our Clinic, has been a valuable aid in the removal of radiopaque foreign bodies beyond endoscopic vision. The case cited illustrates its practical application.

The Alnico bronchoscopic magnet has been found easily maneuverable in the smaller bronchioles and perhaps less traumatic than rigid forceps. However, the latter still have an indispensable place in the extraction of non-magnetic foreign bodies. Even magnetic foreign bodies may require their use.

106 W. 7TH ST.

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VII

THE AURAL APPROACH TO THE PAROTID GLAND

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The otolaryngological surgeon shares with those who do general surgery respect for operations upon the parotid gland because of the varied and important structures encountered within the gland or in relation to it. Two hazards are of particular interest: (a) Everyone fears the possibility of operative damage to the facial nerve. (b) The chance of wounding the internal jugular vein must be considered in dealing with pathology in the medial parotid bed.

The aural approach to surgical parotid lesions, whether tumor, stone, or infection, has given the writer the greatest assurance of controlling unavoidable risks, and the best end results. The gland has an intimate relation to both the lamina of the tragus and the lower portion of the conchal cartilage; to the mastoid tip; to the tympanic part of the temporal bone; the styloid process; and to adjacent muscles, especially the sternomastoid and the posterior belly of the digastricus. The aural surgeon's long and varied experience in dealing with these structures enables him to utilize them for wide and safe exposure of the parotid mass posteriorly in such manner that the root of the styloid process can be seen, and with it the main trunk of the facial nerve before it enters the parotid, and the medial relationship of the internal jugular to the gland can be recognized exactly without the necessity of actual exposure of this vein. Forward dissection of the parotideomasseteric fascia near the angle of the jaw at the lower border of the mandible enables one to "pick up" the mandibular branch of the facial nerve if necessary and follow it backward. That is, the technique to be described offers maximum protection to both the facial nerve and to the internal jugular vein. Because the initial incision usually severs the external jugular vein as it emerges from the lower pole of the gland, the tied venous end offers a useful external landmark in that the seventh nerve branches must lie more superficially than the posterior facial vein before it flows into the external jugular. This vein is usually found just superficial to the posterior border of the ramus of the mandible.

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A final advantage of the aural approach is the ease with which the external carotid artery can be tied, if desired, prior to entering the gland.

The method has certain fundamental principles:

1. As just stated, the intimate relationship of the parotid to the temporal bone and external auditory canal provides an easy approach from behind, permitting the aural surgeon to utilize his intimate knowledge of this region in obtaining adequate exposure.
2. Detachment of the anterior mastoidal insertion of the sternomastoid muscle rapidly reveals the external surface of the posterior belly of the digastricus muscle. This is the great surgical landmark of the parotid bed, as will be seen later.
3. The transverse process of the atlas is easily palpable through this belly as a landmark about halfway between the mastoid tip and angle of the jaw. The internal jugular vein and the last four cranial nerves lie on the anterior surface of this structure. Therefore, in this position the jugular is medial to the lateral aspect of the tip of the transverse process in the sagittal plane.
4. The deep posterior portion of the parotid medial to the mastoid and sternomastoid muscle is made superficial prior to any attack directly upon the gland.
5. This permits an exact localization of the internal jugular at once without ever actually visualizing it. Since the jugular lies directly medial to the exposed posterior belly of the digastricus, and upon, but at a medial level, from the tip of the transverse process of the atlas, there need be no danger of injury to it in deep parotid dissections. This is of great importance in the removal of deeply-placed tumor tissue in the gland.
6. The aural parotid approach enables the surgeon to identify the facial nerve prior to its entry into the gland or at its exit, according to convenience or necessity. To reach the stylomastoid foramen, the lamina of the tragus is followed medially to the porus acusticus, anteriorly; thence medially over the anterior aspect of the tympanic plate to the easily-palpable root of the styloid process. The nerve lies free before entering the parotid for about five to ten millimeters in the bony chink between the mastoid and styloid process, below the stylomastoid foramen.

(Incidentally, the root of the styloid process protects the operator from the jugular bulb; the process itself separates the operator from the carotid sheath and its contained structures.)

To pick up and follow a branch of the facial nerve anteriorly offers a choice between the mandibular branch and the cervical branch, as possible damage to these is not of serious moment in comparison with higher branches. This does not mean that the branch will be actually severed; just the pull of the instruments used in the dissection may induce a temporary paresis. The mandibular branch is the more convenient for which to look because of its anatomical position a few millimeters above the lower border of the mandible, on the masseter and deep to the parotideomasseteric fascia. The Beaver knife with a No. 48 blade used in block dissection of the neck is a good instrument for this purpose. The galvanic current stimulus may be helpful at this point also.

7. The "parotid bed" is visualized as the posterior belly of the digastricus, and the styloid process with its attached muscles. The jugular, internal carotid artery, last three cranial nerves, and pharynx lie more medially. The ninth nerve accompanies the stylopharyngeus muscle.

8. Directly medial to the posterior belly of the digastricus is the occipital artery; then the internal jugular. This and the last three cranial nerves, with the two carotid arteries emerge from the lower border of the muscle.

9. This means that when necessary the external carotid artery can be ligated easily if the technique described below is followed.

10. The position of the intraglandular structures from within—facial nerve, posterior facial vein, external carotid artery—is mentioned explicitly in all anatomy texts. However, the position of the external carotid medial to the angle of the jaw, and ascending usually medial to the posterior border of the ramus is not emphasized, nor is the position of the posterior facial vein external to the posterior border of the ramus. If the operator sees this vein, he realizes that his field is here medial to the fibers of the facial nerve, which invariably are external to the vein.

The position of the facial nerve in its course from the stylo-mastoid foramen through the gland is best visualized by recalling that trunk is first free for about five to ten millimeters; then enters the most medial posterior aspect of the parotid, curving downward, forward, and slightly outward. It divides deeply into two trunks. The superior ascends laterally and superiorly to divide into temporal and zygomatic branches, passing over the ramus to the medial antero-superior border of the gland, to emerge here.

The lower main division seems to be the continuation of the main trunk by its direction; it divides into the lower three branches (buccal, mandibular, cervical) to ascend over the ramus in the case of the buccal and mandibular divisions. The cervical branch crosses external to the posterior belly of the digastricus, as do the external jugular vein and great auricular nerve.

OPERATIVE TECHNIQUE

The detailed technique of the operation is as follows:

A curved incision is made, preferably in a skin fold, from the external surface of the mastoid, near the auricle, downward and forward about 2 cm below the angle of the jaw to the region of the great cornu of the hyoid bone. This will include the uppermost portion of the carotid triangle, and the parotid portion of the submaxillary triangle where a skin flap is turned upward and forward.

A further incision is made closely anterior to and parallel with the lamina of the tragus in its lower portion, and carried downward, then backward, exposing the perichondrium of the external auditory cartilaginous canal, to join the initial incision at a right angle.

The parotideomasseteric fascia is then exposed as far forward as the angle of the jaw, and for about one finger's breadth anterior to the lamina of the tragus. The anterior superior attachment of the sternomastoid muscle to the mastoid process is then removed to demonstrate the sheath of this muscle anteromedially, and in turn the posterior belly of the digastricus. The transverse process of the atlas is easily palpable through this thin muscle. The lowermost portion of the lamina of the tragus is dissected medially to the porus acusticus. The lamina in its entirety may be exposed if desired; care is taken not to penetrate the fissures of Santorini. The capsule of the parotid is easily separated to the base of the styloid process, and the process is gently palpated. No effort is made until later to expose the facial nerve from the stylomastoid foramen to the gland, and then only if such orientation becomes necessary.

It will be found that the deep posterior part of the parotid has become superficial, with a clear conception of the operator as to the position of the internal jugular vein and facial nerve.

A rounded pointless block-dissection knife—and galvanic current stimulator if necessary—can be used to find the mandibular branch of the facial nerve near the angle of the jaw, a few millimeters above the lower border of the mandible. Small superficial incisions are made in the parotideomasseteric fascia parallel with the

course of the nerve until it is found. It can then be followed backward and upward in the glandular substance to the lower main trunk of the facial nerve if this is desirable, depending on the lesion being dealt with.

From this point the dissection can be continued in any direction with maximum safety regarding calculated risks. If the external carotid is to be endangered, it can be ligated in the upper carotid triangle, or in the gland substance

The pterygoid lobe of the parotid is maximally exposed by this approach; so is the prolongation toward the glenoid fossa.

Any portion of the foregoing technique can be applied in parotid surgery, the exposure being proportional to the problem involved. Furthermore, in extensive malignancy of the parotid in which the facial nerve has been sacrificed, the ramus of the mandible can be severed below by a gigli saw cut through the junction of the ramus with the body of the mandible if it is necessary to dissect the infratemporal region and an extensive area of the base of the skull from below.

The writer has used the above-described method in benign mixed tumors of the parotid; in mixed tumor which has undergone malignant degeneration; in metastatic epidermoid carcinoma of the parotid; in malignant extension from the external auditory canal; in papillary cystadenolymphomatosum; and in parotid stone.

REPORT OF CASE

A white male aged 76 entered The Massachusetts Eye and Ear Infirmary complaining of swelling behind the left lower jaw of four months' duration, accompanied by pain on chewing but not on swallowing. Examination showed a non-tender mass in the left parotid region behind and above the angle of the jaw about five centimeters in diameter. The mass was soft in consistency. A preoperative diagnosis of papillary cystadenolymphomatosum was made. The patient's general physical condition was found by the Medical Service of The Massachusetts General Hospital to be adequate for parotid surgery. Although the patient had a positive Hinton test, the Skin Service felt that gumma could be ruled out. A lipiodol sialogram showed a filling defect at the upper part of the parotid. Operation was advised under intratracheal ether.

A curved incision was made from the tip of the mastoid to slightly above the great cornu of the hyoid bone. A skin flap was reflected forward and upward. A further incision was carried along

the anterior margin of the lamina of the tragus from above downward and then backward along the cartilage of the outer surface of the concha at its lower border to join the first incision. The anterior portion of the attachment of the sternomastoid muscle to the mastoid process was removed. The posterior belly of the digastric muscle was exposed together with the entire lamina of the tragus and the anterior bony plate of the tympanic portion of the temporal bone. The root of the styloid process at its attachment to the skull was identified. The cervical branch of the facial nerve was identified in its course over the posterior belly of the digastric muscle while the mandibular branch of the same nerve was identified over the masseter muscle underneath the parotideomasseteric fascia.

This exposure permitted location of the tumor in the depths of the parotid gland by elevating the glandular structure laterally from the posterior belly of the digastric muscle. The tumor was identified on the medial surface of the parotid gland. The cervical and mandibular nerves mentioned above were dissected backward and upward and were found to overlie the tumor. The posterior facial vein was identified and tied in the substance of the parotid gland. The tumor was dissected away from the lateral aspect of the internal jugular vein and was excised with its entire capsule intact and with an attempt to carry with it as much normal parotid tissue as possible without damage to the facial nerve. By having dissected out the two branches of this nerve and being certain as to the position of the nerve as it emerged from the stylomastoid foramen, no damage to the nerve occurred. Because the posterior deep portion of the parotid had to be split in the course of the dissection, a large mass of the gland was excised so that the duct structure was severed only from behind. A rubber dam drain was placed in the lower pole of the incision and the wound was closed.

The same day the patient had a paralysis of the lower three branches of the facial nerve but this disappeared the next day except for weakness of the depressors of the lower lip. The patient's convalescence was entirely uneventful. No salivary fistula occurred. The patient was discharged on the tenth postoperative day. The pathological report of the neoplasm removed was "Mixed tumor of the parotid."

SUMMARY

A simple, adequate, and safe surgical approach to the parotid gland especially useful for otolaryngologists is presented, together with an illustrative case report.

247 COMMONWEALTH AVE.

VIII

THE INDICATIONS FOR RADICAL SURGERY IN THE TREATMENT OF HEAD AND NECK CANCER

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In our endeavor to enhance the survival rate of the cancer patient it is only natural that we use methods more regularly employed rather than resort to procedures not tested by years of clinical experience. Unfortunately, on the basis of our past experiences some of the more familiar methods and techniques have been far from satisfactory in the treatment of certain cancers, and in the light of recent studies² leave much to be desired. It is entirely proper, therefore, for the clinician to continue his quest for newer procedures which may give longer survivals.

Operations for the treatment of head and neck cancer fall into this category. Given tremendous impetus by the advent of multiple blood transfusions, antibiotics, improved anesthesia and better operating techniques the head and neck surgeon is now able to perform extensive operations which include most of the so-called "inaccessible sites" with a negligible mortality rate. However, there is a limit to what radical head and neck surgery can accomplish. Despite the fact that almost any tumor of the head and neck, regardless of its stage, can be resected by the experienced surgeon, enthusiasm for a procedure does not supplant mature judgement; and resectability does not always mean operability.

The following brief histories and comments on patients operated upon in several institutions illustrate the reasons for performing radical surgery. They are taken from patients treated during the past two years. In that period over 50 patients underwent extensive surgery of the head and neck.

REPORT OF CASES

CASE 1.—*For the Relief of an Immediate Threat to Life:* A 56 year old white male clerk had a twice recurrent squamous cell cancer of the anterior floor of the mouth. It was treated first in March, 1951 with irradiation and a recurrence was treated by surgical ex-



Fig. 1.—Postoperative appearance following en bloc resection of both horizontal rami and symphysis of the mandible, the anterior third of the tongue, the floor of the mouth and underlying musculature.

cision and bilateral suprahyoid neck dissection in August, 1951. When first seen in November, 1951 another recurrence was proven by biopsy and the cancer was seen to involve the undersurface of the anterior third of the tongue and mandible as well. The remaining physical examination and x-ray studies were unremarkable.

Several days after his first examination he had a moderately brisk hemorrhage from the irradiated area and residual cancer along the floor of the mouth. It was controlled with some difficulty with a hemostatic pack. Two days later at the Stanford University Hospital a resection of both horizontal rami and symphysis of the mandible, the anterior third of the tongue, floor of the mouth and underlying muscles was performed en bloc with a temporary tracheostomy of five days duration. Postoperative convalescence was unremarkable and he was discharged on the tenth day, eating a soft diet.

Comment: This patient was in immediate danger of severe, perhaps fatal, hemorrhage from a previously irradiated tumor containing residual cancer. His good physical condition, plus a residual cancer still localized to its primary site demanded further surgery regardless of its radical nature. Total extirpation of the tumor not only relieved him of an imminent threat to life, but also gave him a good chance of permanent cure, and left him with a good functional result (Fig. 1). A defeatist attitude, previously expressed and based on what was thought would be a poor cosmetic result and poor rehabilitation, was unwarranted in this cooperative patient.

CASE 2.—For Palliation: A 49 year old white carpenter was seen for the first time in February, 1950 with a very large squamous cell cancer of the floor of the mouth and left lateral border of the tongue. It involved the left side of the mandible to beyond the symphysis. An enlarged lymph node was felt in the left upper neck but the remaining physical examination was unremarkable. A left radical neck dissection and right suprahyoid dissection in continuity with an excision of the intraoral cancer was performed at the University of California Hospital. By dividing the right horizontal ramus of the mandible at its midpoint and the tongue along its right lateral border the intraoral cancer was circumvented and the specimen removed en bloc. A temporary tracheostomy was performed and discontinued five days later. Convalescence was delayed slightly by some necrosis of the neck dissection skin flaps, but the patient was discharged well, on a soft dietary intake, on the nineteenth postoperative day. He returned to his trade and worked regularly without difficulty for exactly one year at which time a metastatic lymph node was felt in the right lower neck. A radical neck dissection on this side was performed, but he died eight hours postoperatively. The cause of death was believed to be cerebral congestion following ligation of a second internal jugular vein.

Comment: With such a very extensive cancer it is reasonable to expect only palliation. Yet despite its extent this tumor was operable because it could be excised with free margins; there were metastases to nodes on only one side of the neck; no previous irradiation had been given, and therefore, primary healing of the oral (the most important) mucosa suture line was assured; a functional result with rehabilitation was certain; and age and general physical condition did not contraindicate surgery. For several reasons, among them mandibular invasion, irradiation therapy was discounted. The fact that a year later lymph node metastases occurred and not local recurrence proves again that in oral cancer the primary tumor is less frequently the source of trouble than are the lymph node metastases. Gratifying palliation, in this case shortened by an unfortunate and unusual complication, was obtained by radical surgery still performed within the confines of proven procedures.

CASE 3.—For Relief of Complications Following Previous Therapy or for Recurrence: A 52 year old white civil engineer had a squamous cell cancer of the left tonsil treated with irradiation therapy in 1947. In 1949 a hard nodule containing cancer was felt along the intraoral margin of the horizontal ramus of the left mandible. A large metastatic lymph node was felt overlying the carotid bulb.

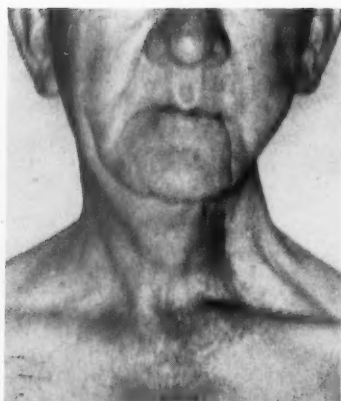


Fig. 2.—Postoperative appearance of patient following left radical neck dissection and left hemimandibulectomy.

There was no evidence of recurrence within the tonsillar fossa. X-rays revealed invasion of the mandible. The remaining physical examination was unremarkable.

A left radical neck dissection and left hemimandibulectomy was performed in continuity at Stanford University Hospital. A temporary tracheostomy was performed, as well. After an uneventful convalescence he was discharged on the twelfth postoperative day. Four months later a subcutaneous nodule which contained cancer was noted at the medial margin of the neck dissection. It was treated with x-ray through a small portal and supplementary radon seed implantation. He has remained well for almost two years (Fig. 2).

Comment: The extent of therapy necessary to treat metastases is well illustrated as the primary cancer in this patient was controlled with x-rays. Only by en bloc resection could the cancer-bearing areas be removed without further dissemination or the patient given any chance of permanent cure. Despite the extensive nature of the surgery a small residual nodule did appear, but responded to local irradiation. None of the metastases taxed the limits of clean surgical dissection despite a neck node 3 cm in size. By incising around the intraoral metastasis widely enough to remove the cancer, yet keeping within the bounds of propriety, the tongue margin was spared and adequate oral mucosa remained for easy, solid closure of the mouth. In addition, rapid healing was expected by the fact that



Fig. 3.—Operative specimen showing localized recurrence on the left lower gum and the extent of surgery performed to remove it.

it was not necessary to cut into the previously irradiated tonsillar region. His anticipated return to full, useful life with a fair prognosis for the future justified the decision for extensive surgery.

CASE 4.—A 48 year old white electrician was treated in 1947 with irradiation therapy to a squamous cell cancer of the posterior aspect of the left lower gum. A recurrence was proven by biopsy in 1949. There were no enlarged lymph nodes in the neck which suggested metastasis and x-ray studies showed only questionable mandibular involvement. The remaining physical examination was unremarkable. At the U. S. Veterans' Administration Hospital in Oakland, California, a left radical neck dissection was performed in continuity with a left hemimandibulectomy (Fig. 3). A temporary



Fig. 4.—Operative specimen showing cervical oesophageal cancer with overlying larynx and thyroid.

tracheostomy was also performed. Postoperative convalescence was uneventful and he was discharged on the twelfth day to resume his occupation.

Comment: Despite the relatively localized nature of this patient's recurrence it was assumed that neck node metastases would soon occur, if not actually then present, due to the duration of the cancer, its recurrent nature, and its primary location. Because another cancericidal course of irradiation was deemed unwise surgical removal of the tumor was the only alternative. Once this decision was made the importance of complete, en bloc removal of the cancer and its metastatic areas was paramount. Although it is felt that one should not routinely adhere to the dictum of prophylactic neck dissection,^{1, 3, 5} certainly in the recurrent and advanced cancers it merits individual consideration. In addition, were this recurrent cancer treated by local mandibular resection alone the resulting scarring and fibrosis of the upper regions of the neck makes subsequent neck surgery technically dangerous, and clean dissection difficult.



Fig. 5.—Postoperative appearance showing temporary pharyngostome with permanent tracheostomy directly anterior.

CASE 5.—For Cure: A 38 year old female telephone operator had an epidermoid cancer of the anterior wall of the cervical esophagus which showed invasion of the overlying cricoid cartilage. An independent, smaller, second cancer was present on the posterior wall of the hypopharynx above the cricopharyngeus sphincter. There were no neck node metastases. At the Mount Zion Hospital, San Francisco, California, an en bloc resection of cervical esophagus, larynx and overlying thyroid gland with identification and preservation of the four parathyroid glands was performed (Fig. 4). This left a permanent tracheostome and a temporary pharyngostome and esophagostome (Fig. 5), which were closed two months later by construction of a cervical esophagus from the adjacent skin of the neck (Fig. 6). Swallowing is excellent and she is learning to use an esophageal voice. She has returned to work in a different department of the same company.

Comment: The five year survival rate of esophageal cancer in any region along its course is not very high and results in the cervical portion are among the poorest. To take these patients out of the realm of irradiation therapy and perform extensive surgery of this type may not be the cancer panacea but it may enhance survival rates with considerably less morbidity. Application of this procedure for primary laryngeal cancers which extend into the esophagus is becoming commonplace, and offers a chance of limiting a disease



Fig. 6.—Appearance following construction of a skin-lined oesophagus.

which may remain localized for a surprisingly long time. When performed in continuity with a neck dissection, not recommended as a prophylactic procedure, the scope of therapy includes all cancer-bearing areas.

CASE 6.—A 51 year old female school teacher had an anaplastic carcinoma of the right maxillary sinus. Erosion of the anterior and lateral walls of the antrum was seen on roentgenograms but the floor of the orbit appeared free. The remaining physical examination was unremarkable. In 1949 a bilateral external carotid ligation, which is no longer done for this procedure, and a radical resection of the right maxilla was performed. A cheek flap approach was used by splitting the upper lip in the midline, carrying the incision paranasally and infraorbitally, and laying the cheek back laterally so as to expose the underlying maxilla. It was removed completely along with the ethmoid and sphenoid cells. During surgery cancer was thought to have infiltrated the floor of the orbit but because of a previous agreement with the patient an exenteration of orbital contents in continuity was not performed. A split thickness skin graft was placed over the raw inner margin of the cheek flap. Post-operative convalescence was uneventful and an oral prosthesis was made to cover the defect in the hard palate.

Two months later recurrence on the floor of the orbit was proven by biopsy and an exenteration of the orbital contents was performed. This was followed by irradiation therapy to the orbital area only. She has remained well (20 months) and resumed teaching without difficulty.

Comment: The radical nature of this procedure can only be tempered by the poor results of antral cancer with the more usual methods. Despite the fact that the results of a two year follow-up on one patient are not significant it cannot be denied that this patient (who was referred to as totally hopeless) represents a source of encouragement. During the past two years 17 patients have had this type of operation with encouraging results, thus far. The extensive nature of the cancer was still within the limits of surgical resection. Prosthetic devices which are satisfactory for complete rehabilitation following surgery of this nature is further reason for the procedure. The fact that supplementary irradiation therapy could be judiciously given in a curative manner strengthens the indication for surgery and demonstrates the need for cooperation on the part of two separate specialties.

COMMENT

Extensive operations designed for the treatment of intraoral cancer have as their underlying tenet the removal in continuity of the primary tumor and the lymph nodes to which that tumor has or will metastasize. Such a principle is exemplified by Halsted's classical radical mastectomy and Miles abdominoperineal resection of the rectum.

In the head and neck the mandible has represented a stumbling block to this ideal concept because of a natural reluctance on the part of all trained surgeons to perform mutilating surgery. However, when a tumor is operable, rapid healing anticipated, and a good functional result obtained with adequate rehabilitation of the patient the cosmetic factor loses significance.

The importance of removing a portion of the mandible can be realized after a brief review of the lymphatic anatomy of this region. In 1902 Polya and Navratil¹ pointed out that in about 50 per cent of normal individuals the lymphatics of the tongue and floor of the mouth pass through the periosteum of the mandible on their way to the lymph nodes of the upper neck. Ward and Robben⁸ have recently reemphasized this point. On the basis of experience alone, the proximity of lymphatic pathways to the mandible is seen in the all too frequent recurrence of oral cancers along the mandibular

margin or of lymph node metastases fixed to the bone. This was vividly illustrated by Case 3 where the primary cancer was in the tonsil. The feeling that intraoral cancer can be treated in a wholly local manner does not appear very tenable in the light of these and other studies.^{1, 3, 6, 7, 9} The necessity of removing a portion of the mandible whenever cancer is close to the jaw should be emphasized.

The wisdom of performing radical surgery in other parts of the head and neck (Cases 5 and 6) can only be proven with the passage of time. In the hands of the surgeon familiar with these problems they represent another method of dealing with a difficult therapeutic problem. Not infrequently judicious, supplementary irradiation therapy is of marked benefit.

CONCLUSION

1. There is a limit to what radical head and neck surgery can accomplish; resectability does not mean operability.
2. There are definite indications and requirements for performing radical surgery.
3. When performed on the suitable patient such surgery should be complete.
4. Failure to remove a portion of the intervening mandible is cause of frequent recurrences in the treatment of intraoral cancer.
5. The wisdom of performing radical surgery in other parts of the head and neck is being studied. Preliminary reports are gratifying.

450 SUTTER STREET.

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IX

ACOUSTIC TRAUMA IN CHILDREN

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Comparatively little information is available concerning the sensitivity of the inner ears of children to loud noises. The probable infrequency of exposure to noises loud enough to produce acoustic trauma and the difficulty in accurately testing the hearing of young children may account for this paucity of information.

Three patients referred to this center for further study by a school nurse during the past year indicate that more attention should be accorded the effect of loud noises upon the hearing acuity of children. In all three children, permanent hearing defects were produced by inadvertent exposures to cap pistols or fire crackers. The hearing defects were of the inner ear, or so-called nerve deafness type, and similar to those encountered among military personnel who had been exposed to gunfire. This type was first described by Bunch¹ and carefully investigated by Ruedi,² Perlman³ and others. The loss is generally in the higher frequencies and may occur predominantly in one frequency, the so-called C⁵ dip at 4096 cycles. The hearing loss is generally not progressive, but once established, is irreversible. Middle ear damage rarely accompanies this type of inner ear involvement, unless the source of the noise is very close to the ear and is of a very intense low frequency. Rupture of the ear drum has recently been encountered by Eldredge,⁴ with exposure to extremely loud high pitched sound.

The detection of these cases of hearing loss was made possible by carefully sweeping the frequencies 500, 2000, 4000 and 8000, at 15 decibels in each individual subject in a quiet room and utilizing all the important principles of good audiometry.

CASE 1.—The first child seen was nine years old and presented no clinical symptoms. He denied any hearing loss or tinnitus. The hearing defect was detected by his school nurse during routine screening with an audiometer. A detailed history revealed that a year ago, this child had been exposed to very loud cap pistol fire. The noise came unexpectedly and immediately produced deafness and ringing tinnitus in both ears. Shortly thereafter, the ringing and deafness

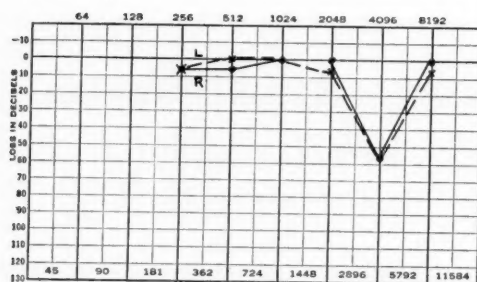


Fig. 1.

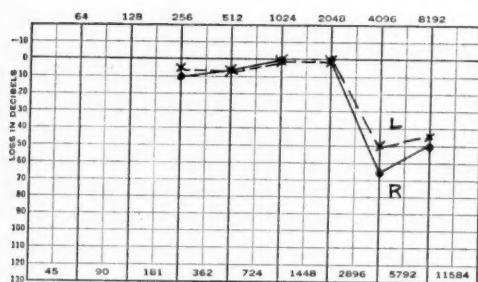


Fig. 2.

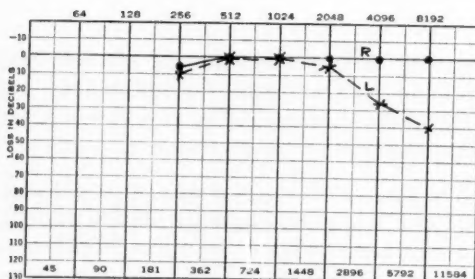


Fig. 3.

subsided. Further questioning indicated that tinnitus is still occasionally present under very quiet conditions. Speech discrimination was reduced for phonetically balanced words, but the speech reception was normal. The audiogram shown in Figure 1 shows a typical bilateral C⁵ dip, characteristic of acoustic trauma.

CASE 2.—The second patient was a 16 year old boy who was referred because of a slight ringing tinnitus and difficulty in understanding speech in a noisy environment. This difficulty, so typical with high tone loss, was aggravated when several people were speaking simultaneously. He also had some difficulty hearing on the telephone. Careful analysis of his past history showed that at the age of six, this youngster had experienced a severe exposure to cap pistol fire quite close to his ears. From that time, he was aware of constant ringing tinnitus and hearing impairment. At the age of ten, his symptoms were aggravated by acoustic trauma produced by the firing of a .22 caliber pistol. The patient did not have any speech defect. The audiogram shown in Fig. 2 demonstrates a bilateral high tone loss sufficient to produce difficulty in discriminating certain consonants, particularly the sibilants. This difficulty is more pronounced in the presence of ambient noise or speech due to the masking and confusing effects. This accounts for the difficulty in discriminating speech, especially on the telephone, where it has been distorted through amplification.

CASE 3.—The third patient was a 12 year old boy who presented no clinical symptoms referable to the ears. His hearing defect was detected during routine screening. The history revealed that several years ago this youngster experienced sudden deafness and ringing tinnitus as a result of a loud cap pistol firing close to his left ear. Both symptoms subsided the same day without recurrence. The audiogram shown in Fig. 3 reveals a left sided inner ear hearing defect in the higher frequencies. In such a situation, no clinical hearing impairment would be anticipated, since the loss is comparatively mild and is unilateral.

A careful physical and otological examination of all three patients revealed no significant abnormalities. The membrani tympani and middle ears were all normal and there was no evidence of adenoid hypertrophy in the nasopharynx.

DISCUSSION

All three patients have been closely studied during the past year, and numerous audiograms repeated under standard conditions

using a calibrated audiometer. The physical examinations excluded the adenoids as possible etiological factors in producing the hearing defects. The middle ears in all patients showed no pathological changes. Repeated hearing tests demonstrated there was no evidence of change in hearing acuity of any of the youngsters. As may be expected, only the child with bilateral hearing loss to a considerable degree presented symptoms of clinical hearing impairment. It is not uncommon to encounter adults, as well as children, who are completely unaware of even profound unilateral hearing losses if the defects have been present since early childhood. The hearing defects in these three patients were found during the routine testing of 800 school children. Numerous other types of hearing losses were also encountered.

While these cases are two few to draw any definite conclusions, it seems obvious that the possibility of acoustic trauma in children deserves more attention. If permanent hearing damage can be produced so readily by apparently innocuous cap pistols and fire crackers, then preventative measures should be instituted. Furthermore, children with established hearing defects and those sensitive to acoustic trauma should be protected to avoid further hearing damage. Since the screening measures now in general use, particularly those utilizing words and numbers, often fail to detect certain types of hearing defects, more careful and useful techniques should be instituted. Trained and interested personnel are of primary importance in conducting the tests.

CONCLUSIONS

Permanent hearing defects may be produced in young children by the sound accompanying the firing of cap pistols and fire crackers.

These hearing defects are of the inner ear type and similar to those encountered in military personnel whose hearing acuity has been damaged by exposure to gunfire.

The hearing defects resulting from acoustic trauma in these patients are probably not progressive.

More careful screening techniques are advocated to detect certain types of hearing defects not accompanied by clinical symptoms and indicating the importance of preventative measures.

1721 PINE STREET.

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DISPLACEMENT BY "REVERSE VALSALVA"

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Since the original description, in 1926, of the displacement method for instilling fluids into the paranasal sinuses,¹ this method has enjoyed widespread acceptance in the treatment of sinus disease. It will be the purpose of this paper not to discuss or evaluate the efficacy of displacement therapy, but to present a simplified method of displacement for those who wish to instill fluids into the sinuses.

Displacement, without the use of applied suction, has been attempted in the past with varying degrees of success. A review of the literature reveals two papers dealing with this subject.

Fraser,² in 1927, described a method for instilling opaque fluids into the sinuses by having the patient alternate strong inspiration and expiration against closed mouth and nostrils. This maneuver was designed to produce the necessary negative intranasal pressure for displacement. An exaggerated Proetz position was used with the patient alternating forced inspiration and expiration three times, for three seconds at a time. Fifteen cc of opaque material were instilled into the nose each time. The author states that the method was used successfully in 100 cases but gives no statistics regarding the frequency or extent of filling. Although this method was successful, it is readily seen that it is fraught with the danger of blowing the diagnostic or therapeutic fluid into the middle ear during the forced expiration against closed mouth and nostrils (Valsalva Maneuver).

Sternberg and Satz,³ in 1930, used the Valsalva maneuver alone to obtain displacement. In this case it was felt that the required negative pressure was produced when the subject suddenly discontinued his forced expiration. The authors studied 25 patients with nasal allergy by this method, using 10 cc of radiopaque oil in each case. The sphenoids were filled completely in ten cases, partially in six cases, and not at all in nine cases. The posterior ethmoids were filled completely or partially in 15 cases, and the frontals completely or partially in eight cases. These results must be considered very

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good when one realizes that the authors were dealing with allergic patients, in whom displacement is notoriously difficult. It is again apparent, however, that there is great danger to the middle ear for the same reasons noted in the description of Fraser's method.

No references were found describing displacement by forced inspiration against closed mouth and nostrils (Reverse Valsalva).

"REVERSE VALSALVA" METHOD

In the method under consideration in this paper the patient is placed in the supine position with the head hyper-extended over the edge of a table or bed, so that the alae nasi are parallel with the floor. Three to five cc of fluid are instilled into each nostril and the patient inspires forcibly while holding the mouth and nostrils closed (Reverse Valsalva maneuver). The mouth is opened and the patient exhales slightly between each forced inspiration. One normal, oral, inspiration after every three to four forced inspirations is sufficient to keep the patient comfortable. This is repeated to a total of seven to eight inspirations against closed mouth and nostrils. Another three to five cc of fluid are then instilled into each nostril and the process is repeated.

It is important that the patient exhale slightly after each forced inspiration so that the negative pressure will be broken, allowing fluid to enter the sinus and replace the "bubble" of air evacuated from the sinus by negative pressure.

It is also important that the procedure be divided into two stages, so that a new instillation of fluid may be made to replace that displaced into the posterior group of sinuses during the first series of inspirations. To conserve what fluid is left after the first series of inspirations, the patient is not allowed to change position between stages.

Unlike the methods of Fraser, Sternberg and Satz, there is no danger of forcing fluid into the middle ear by this method since only negative pressure is used. At no time is any positive pressure produced, to force fluid into or through the eustachian tube. As regards "displacement" of fluid into the middle ear, Proetz^{1, 6} has shown rather definitely that this does not occur, probably due to the length of the eustachian tube and to the fact that it is ordinarily closed most of the time.

To understand the mechanism of displacement by this method, one should be familiar with the principles of displacement in general and with the standard Proetz displacement method. The writer will attempt to describe the method and its principles briefly, but for a

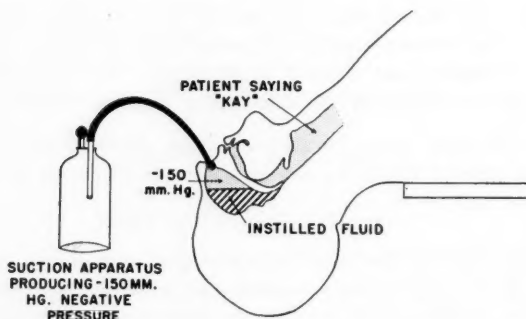


Fig. 1.—Method of production of negative pressure in the standard Proetz method of displacement.

more detailed description, the reader is referred to previous publications on the subject by Proetz.^{1, 4, 5}

According to the method of Proetz, the patient is placed in the supine position with the head extended. Fluid is then instilled nasally, to form a reservoir of fluid in the nose and nasopharynx, covering the ostia of the sinuses into which it is desired to displace fluid. Suction is then applied to the nostrils (the patient saying "kay-kay-kay" to close off the nasopharynx) producing a negative pressure above the fluid reservoir each time the patient says "kay" (Fig. 1). This negative pressure evacuates a "bubble" of air from the sinus and, when the pressure returns to normal (between "kays"), a bubble of fluid replaces the space previously occupied by air in the sinus. In this manner, varying amounts of fluid can be displaced into the sinuses, providing their ostia are patent and inundated by the reservoir of fluid.

The mechanism involved in the "Reverse Valsalva" method is essentially the same as in the Proetz method, with the exception that the negative pressure over the fluid reservoir is developed in a different manner. Instead of negative pressure being produced over the nasal surface of the fluid by applied suction, the patient produces his own negative pressure over the oropharyngeal surface of the fluid reservoir. This negative pressure is produced by the expanding lungs against closed mouth and nostrils (Fig. 2). The requisites of displacement require only that a sufficient negative pressure be present over the surface of the fluid, there being no difference whether it is over the nasal or oropharyngeal surface.

Does this pulmonary expansion produce sufficient negative pressure to allow displacement? Braune and Clasen⁶ measured the maxi-

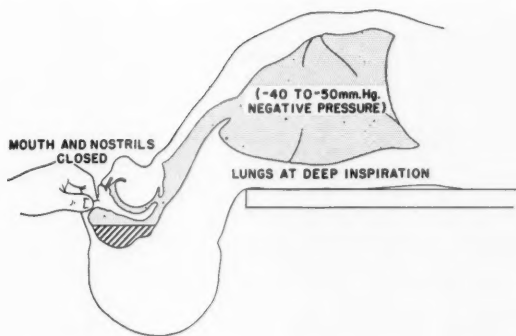


Fig. 2.—Method of production of negative pressure in the "Reverse Valsalva" method.

imum amount of negative pressure produced by forced inspiration against closed mouth and nostrils as -57 mm of Hg. These measurements were made with a mercury manometer occluding one nostril, with the other nostril and mouth closed (the conditions present in the "Reverse Valsalva" method). Best and Taylor⁹ estimate the pressure at -40 to -80 mm of Hg. Thus, it would seem safe to assume that from -40 to -50 mm (Hg) of negative pressure is produced by this maneuver. This is considerably less than the -150 mm Hg of pressure recommended by Proetz,^{4, 7} but that it is sufficient to allow displacement of all the sinuses except the frontals, will now be demonstrated.

METHOD OF TESTING AND RESULTS

To determine the efficacy of displacement by the "Reverse Valsalva" method, the author first tried the method on himself with encouraging results. Twenty-four patients were then chosen, at random, from the Out Patient Department of the Massachusetts Eye and Ear Infirmary, making a total of 25 test subjects. Most of the group had complaints of postnasal drip, since this was the group of patients most easily persuaded to have their sinuses investigated. Of this group, 12 were male and 13 female. The ages varied from 16 to 65 years. In order to prevent complications in the interpretation of results, vasoconstrictors were not used prior to testing.

Approximately three to four minutes were spent in explaining to the subjects what they were to do, since in all cases this was their first experience with the procedure.

TABLE 1.—ILLUSTRATING THE PRESENCE OR ABSENCE OF RADIOPAQUE OIL IN THE VARIOUS SINUSES USING THE "REVERSE VALSALVA" METHOD IN 25 TEST SUBJECTS.

NO.	SUBJECT	DATE	ETHMOIDS		ANTRA		SPHENOIDS		FRONTALS	
			RT.	LT.	RT.	LT.	RT.	LT.	RT.	LT.
1	GR.	1/11	+	+	+	+	+	+		
2	CM.	2/3	+	+	+	+	+	+		
3	AS.	2/3	+	+	+	+	+	+		
4	RA.	2/3	+	+						
5	RM.	2/5	+	+			+	+		
6	SB.	2/5	+	+	+		+	+		
7	CR.	2/6	+	+	+		+	+		
8	GO.	2/6	+	+	+	+	+	+		
9	DG.	2/12	+	+	+	+		+		
10	MR.	2/15	+	+						
11	EG.	2/17	+	+		+	+	+		
12	WK.	2/23	+	+						
13	RH.	3/6	+	+	+	+	+	+		
14	WS.	3/6	+	+	+	+	+	+		
15	LC.	4/16	+	+	+	+				
16	HF.	4/24	+	+	+	+				
17	LD.	4/26	+	+	+	+	+			
18	WP.	4/27	+	+	+	+	+	+		
19	SK.	4/28	+	+	+	+	+	+		
20	MB.	5/2	+	+	+	+	+	+		
21	J.F.	5/26	+	+	+	+	+	+		
22	F.P.	7/25	+	+	+	+	+	+		
23	J.L.	7/27	+	+	+	+	+	+		
24	D.L.	7/27	+	+	+	+	+	+		+
25	J.R.	7/31	+	+	+	+	+	+		

25	25	20	18	17	21	0	1
100%	100%	80%	72%	68%	84%	0%	4%

25	22	22	1
100%	88%	86%	4%

The maneuver of forced inspiration against closed mouth and nostrils was practiced by the subject once or twice in the erect position before assuming the supine position. The procedure was as described previously, using a radiopaque solution consisting of one part Iodochloral to two parts olive oil.

Following the displacement procedure, the patients were sent to the x-ray department where radiograms were made to determine the presence of radiopaque oil in the sinuses. Three views were taken: anteroposterior, lateral and submento-occipital. A horizontal beam was used in all views to insure the presence of a fluid level, making demonstration of the fluid easier.

The presence, or absence, of radiopaque oil in the various sinuses in the 25 subjects is tabulated in Table 1. The + marks indicate that radiopaque oil was present in the sinuses. No attempt was made to indicate the amount of oil present or to note pathological findings, since it was the purpose of this study to prove only that displacement does occur with the "Reverse Valsalva" method.

In the first 12 subjects 10 cc of oil were used, while 20 cc were used in the other 13. It will be noted that much better filling of the

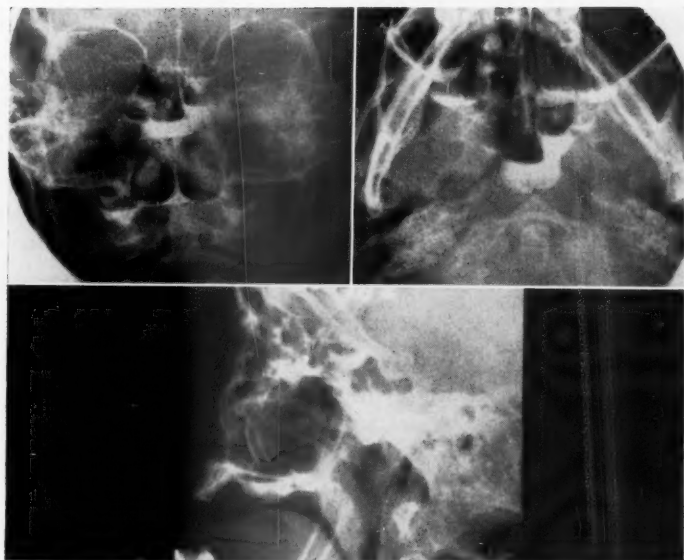


Fig. 3.—X-rays showing displacement of radiopaque oil into all sinuses except the frontals.

maxillary sinuses was obtained using 20 cc. This is easily explained on the basis that the maxillary ostia are much more apt to be covered when using a larger reservoir of fluid. It is also of practical importance since it indicates that a total of 20 cc of fluid should be used if one wishes to treat the maxillary sinuses by this method of displacement, whereas 10 cc are sufficient for the posterior sinuses.

X-rays of one case, in which 20 cc fluid was used, are illustrated in Figure 3.

Radiopaque oil was present in the ethmoids, bilaterally, in all cases (100%); in one or both maxillary antra in 22 cases (88%); and in one or both sphenoids in 22 cases (88%). In only one case did oil enter the frontal sinuses.

The author is aware that 25 cases does not constitute a large series and that the percentage might vary with more subjects, but since the percentage of displacement was so high, it is felt to be of significance. Also, it must be remembered that these were not all "normal" subjects and filling of many individual sinuses was probably prevented by pathology in the sinuses or their ostia. It is also

felt that the amount and frequency of filling would probably be greater when using the thinner and lighter treatment fluids than the rather thick, heavy oil used in this study.

The method was attempted on two children, aged eight and ten, without success. They did not seem to grasp fully what was expected of them and tended to be frightened by the fluid in their nose, so that they did not cooperate well. Although the method requires no great amount of intelligence, cooperation is essential and the writer doubts that the method would be successful, very often, in children under 12 to 13 years of age.

ADVANTAGES

This method has the advantage that no equipment is needed other than a syringe to instill the fluid into the nose. It does not require the availability of suction apparatus or the presence of a physician.

In regard to treatment, it is apparent that here is a method of displacement which the patient can use himself at home as often as his physician deems advisable. For use at home the patient should have a 30 cc measuring glass to measure the required amount of fluid and a 30 cc rubber ear syringe to instill the fluid into the nostrils. The patient can either instill the fluid himself or have someone else do it. Such home treatment has been tried in a number of cases and these patients report that they are able to carry out the procedure without difficulty. For shrinkage, the solution used in these cases was $\frac{1}{4}\%$ ephedrine in normal saline.

The writer has not had occasion to use this method in a sufficient number of cases to draw any conclusions regarding therapy. It would seem, however, that one might expect better therapeutic results with this method, which can be used daily without inconvenience to the patient, than with the standard method which requires an office visit and is, therefore, used with less frequency. This is a question which only time, and trial in a large number of cases, can answer.

SUMMARY

(1) A simplified method for displacement of fluids into the ethmoid, maxillary and sphenoid sinuses is described.

(2) A series of 25 cases is presented, demonstrating that radiopaque oil was displaced into the sinuses in a high percentage of cases by this method.

(3) Advantages of the method are that it requires no special equipment and can be carried out by the patient at home as often as desired.

The author acknowledges with gratitude, the kind assistance of Dr. A. S. MacMillan in checking the presence or absence of radiopaque fluid in the radiograms done in connection with this study.

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XI

BACTERIAL AND CYTOLOGICAL DIAGNOSTIC CRITERIA IN NASAL AND SINUS DISEASE

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Rhinology in the past has relied mainly on physical methods for diagnosis. Physical examination, transillumination and roentgen examination have been the established approaches in the evaluation of nasal and sinus problems. These methods are still emphasized in most texts, yet often they do not lead to definitive diagnosis.

During the past several decades, lavage of the large sinuses has been indicated as a valuable additional diagnostic method. Frequent use of this procedure for diagnosis has demonstrated that secretion can be washed out of a maxillary antrum or sphenoid sinus, for instance, even though transillumination and x-rays have shown the sinus to be clear. The roentgen examination has more reliability than transillumination, but both these methods can fail to detect the existence of secretion.

The problem most commonly encountered in rhinologic diagnosis is the differentiation of infectious from non-infectious disorders of the nose and sinuses. Many of these non-infectious problems belong to the broad category of vasomotor rhinitis. Allergic rhinitis comprises a definite entity in this category. Skin testing for pollen and other types of sensitivity has proved valuable in distinguishing allergic rhinitis from other diseases of the nose and sinuses. It is now being recognized that in a large number of patients suffering from vasomotor rhinitis, the etiologic factors may be physical, psychological or constitutional. The use of local medicaments may also be responsible for intranasal vasomotor reactions.

The term "infection" has been used loosely and applied inaccurately in the past in the consideration of nasal disorders. It should be assumed that an infection can exist in the nose only when the elements of infection are present. To prove the existence of infection, it is not only necessary to demonstrate the presence of microorganisms

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usually responsible for disease but the active multiplication of these microorganisms. To complete the picture, secretion or discharge to be regarded as purulent must contain large numbers of polymorphonuclear neutrophils. On the other hand, nasal discharge which lacks these elements should not be considered unconditionally as a manifestation of infection. As a rule, secretion without the elements of infection has a different diagnostic connotation.

For these reasons the term "secretion" has been used intentionally in this discussion to describe nasal discharge. The designation of mucus or pus should be reserved for characterization only after microscopic examination of the secretion has been made. Very often the nature of the secretion can be determined only in this manner. It is true that an obviously purulent infection can be recognized by direct examination. But such a case rarely presents a problem in diagnosis. It is the instances in which mucus is mistaken for purulent secretion that invite erroneous diagnosis and treatment. One may be reminded of the simple admonition given to students of clinical microscopy that a cloudy urine doesn't necessarily imply the presence of white blood cells or infection. Likewise, secretion, thick or thin in consistency, small or large in amount, in the nose or in a sinus, does not predicate infection. Excessive activity of the mucous membrane of the nasal cavities or sinuses can produce secretion similar in appearance to that encountered in infection. On the other hand, a very small amount of secretion may be filled with pathogenic microorganisms. Thus, bacteriologic and cytologic study made routinely on nasal and sinus secretion, as is done in the examination of secretions and discharges from other sites and lesions, will improve the diagnostic accuracy of nasal and sinus disease.

In the analysis of urines and cerebrospinal fluids, the elements which constitute infection are usually definite. A diagnosis of infectious or bacterial meningitis, for instance, is made only if a microorganism is isolated and cytologic and chemical changes occur in the fluid. I can recall the finding of *Streptococcus hemolyticus* in appreciable numbers in the spinal fluid of a patient with lateral sinus thrombosis. In view of the fact that there was no increase in white blood cells and no chemical alteration of the spinal fluid, a diagnosis of bacterial meningitis was not made. The presence of *Streptococcus hemolyticus* in the spinal fluid in this instance proved to be a transient invasion from a bacteremia.

The criteria of infection and of lack of infection on the basis of bacteriologic and cytologic studies should be added to the diagnostic armamentarium of nasal and sinus disease. It should be realized that

these diagnostic investigations are not universally applicable or infallible. The accuracy of such diagnostic criteria cannot be expected to be greater than any ordinary laboratory procedure. It has been my experience that this approach to diagnosis has proved to be more helpful than the standard methods alone.

The technic for culturing nasal and sinus secretion which has been found to be practically useful and efficient has been as follows: A platinum loop is passed into the sphenoethmoidal recess and middle meatus and over the turbinates to collect the desired secretion. It is believed that the platinum loop is far superior to a cotton applicator, which is liable to cause gagging and contamination from nasopharyngeal secretion. When a nasopharyngeal culture is desired, a curved loop is passed through the mouth into the nasopharynx. When performed by a laryngologist, contamination can be avoided. Secretion from a sinus, collected in a basin under "surgically clean" conditions, is aspirated into a capillary pipette for culture inoculation. Cultures are made routinely on blood agar plates alone. Not only are microorganisms easily grown and identified on blood agar but the opportunity for quantitative estimation is also afforded by this method.

Spreads of secretion are stained with Wright stain for microscopic study of cellular elements and microorganisms. Of course, the Gram stain is necessary to differentiate the Gram positive and negative microorganisms. The Hansel stain is of value for clearer delineation of the eosinophile.

If staphylococci are present, the accepted biochemical tests should be made to determine pathogenicity and nonpathogenicity. A staphylococcus which coagulates plasma, ferments mannite and which produces hemolysis on blood agar is frequently regarded as a pathogen or potential pathogen. A staphylococcus with contrary reactions is considered, as a rule, to be a nonpathogen. The former type of staphylococcus is labeled A, the latter B.

The information which should be obtained in the microscopic examination of nasal and sinus secretion is the following: (1) the presence and amount of mucus, (2) the character of cells, (3) the number and types of microorganisms. In allergic and vasomotor rhinitis, or in an actively secreting nasal mucous membrane, mucus and eosinophiles may be present in varying amounts in the spread. Although allergic and vasomotor rhinitis may exist without eosinophiles appearing in the nasal secretion, their presence in moderate and in especially large numbers strongly suggests such a diagnosis, particularly if no microorganisms are seen in the spread. On the other

hand, a large number of white blood cells and microorganisms in quantities which make their discovery not too difficult usually indicate infection. A correlation of the kind and number of microorganisms found on examination of nasal and sinus spreads with those of cultures made of the same secretion can provide significant information as to the nature and severity of an infection.

Inasmuch as pneumococci, hemolytic streptococci, *Streptococcus viridans* and *Staphylococcus aureus* A in large numbers, *Hemophilus influenzae* and usually parainfluenzae and *Klebsiella pneumoniae* are very rarely found in the normal nose and sinus, isolation of any of these microorganisms from the secretion in the nasal cavity or irrigated from a sinus strongly suggests the presence of infection. If spreads of the secretion on stained slides show the same microorganisms and large number of neutrophils, the existence of infection usually has been further substantiated. The amount or character of secretion should not be considered as an index of infection. It should be mentioned that these microorganisms can be isolated from nasopharynges which show no evidence of infection. In other words, these potentially pathogenic microorganisms are present in the normal nasopharynx. It is my belief that the nasopharynx is the carrier-focus of pathogenic microorganisms which spread into the nose and cause infections when the antibacterial barriers are broken by lowered tissue resistance.

On the other hand, *Staphylococcus albus* B, *Neisseria* species, diptheroids, and usually *Staphylococcus albus* A *Staphylococcus aureus* B, *Staphylococcus aureus* A in small numbers, are present in the normal nose and are not associated with infection. Thus, if any of these microorganisms, alone or in combination, are cultured from nasal or sinus secretion, it is unlikely that infection exists. If spreads of such secretion show no microorganisms, or just one or two, and a considerable amount of mucus, then the evidence is strong that the disease is not one of infection. Rather, the secretion should be regarded as a manifestation of mucous membrane activity. It has been observed that a severe eosinophilic rhinitis can produce secretion with purulent characteristics, yet no pathogenic microorganisms need be isolated from such secretion. Also, in my experience, large amounts of secretion obtained from maxillary antrums have yielded sterile cultures or nonpathogens. Spreads of these secretions invariably exhibited no microorganisms but mucus shreds and cellular elements in varying amounts. However, the amount of mucus and its proportion to cellular elements is much greater than seen in infections.

The etiologic agent of a sinus infection occasionally can be a microorganism which is usually nonpathogenic. For instance, I have recently treated an acute frontal sinusitis due to *Proteus vulgaris*. Before such a microorganism is accepted as the cause of the infection, it should be repeatedly isolated and be identified by microscopic examination of a spread of the secretion. In the patient mentioned, the Gram negative bacilli were present in large numbers in the direct spread.

A sinus infection, the secretion of which shows Gram positive cocci on spreads but fails to grow any colonies on repeated cultures, should suggest the possibility of an anaerobic microorganism, such as anaerobic *Streptococcus hemolyticus*. I have observed an anaerobic streptococcal infection of a maxillary antrum associated with erythema nodosum. These lesions disappeared, the sedimentation rate and the temperature, which had been elevated, returned to normal and systemic manifestations of the illness subsided with the cure of the sinus infection.

With new antibiotics constantly appearing, bacteriologic investigations with sensitivity tests on a routine basis are essential for the proper utilization of specific antibiotic therapy. This principle is generally accepted in theory but not in practice. I can recall an acute frontal sinusitis due to *Hemophilus influenzae* which responded to therapy after the administration of sulfadiazine and streptomycin, a number of *Staphylococcus aureus* A infections which were resistant to penicillin but sensitive to aureomycin, and the acute frontal sinusitis caused by *Proteus vulgaris*, mentioned above, which reacted favorably to chloromycetin but not to aureomycin.

Study and evaluation of the secretion in the nose and sinuses are especially helpful in the differential diagnosis between vasomotor rhinitis and sinusitis and infectious rhinitis and sinusitis. The clinical picture of these two conditions is often indistinguishable, particularly in children. It should be emphasized that in uncomplicated vasomotor rhinitis, secretion may be irrigated from the sinuses as well as being present in the nasal cavities. To obtain such secretion on lavage is not indicative of infection.

Precision in diagnosis of nasal and sinus infections is also necessary to restore the problem of foci of infection of these areas on an acceptable basis. In the past few decades, the relationship of foci of infection of the paranasal sinuses to systemic diseases has been placed in a confused if not questionable state. The main reason for this, in my opinion, has been the incomplete and inadequate information obtained from investigations of nasal and sinus disease and con-

cerning the specific type of infection, when infection existed. Thorough bacteriologic and cytologic examinations along the lines that have been indicated, with correlation of both studies, will help greatly to clarify the relationship that does exist between nasal and sinus infections and systemic diseases.

SUMMARY

It is suggested that microscopic study of spreads of nasal and sinus secretion and cultural study of the same secretion should be used as major criteria in the determination of nasal and sinus diseases. A correlation of findings on spread and culture permits the establishment of precise diagnostic information. Such data can be very helpful in differentiating the infectious from the noninfectious diseases of the nose and sinuses.

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XII

THE ADULT AND HIS HEARING PROBLEM

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All patients, infant or aged, who have a hearing loss, are faced with a problem that has personal, social and economic implications,^{1, 2, 3} and no true understanding can be reached unless these aspects are thoroughly discussed. For the purpose of this presentation, however, we propose to speak about the adult between the ages of 21 and 60 whose hearing acuity has gradually decreased as the result of non-suppurative otologic disease and who finds himself, at a critical time in his life, confronted with important decisions to make relative to methods and means of improving his hearing.

There is no doubt but that he needs help of a very special kind and he needs it first from the otologist, to whom he should be turning in increasing numbers. The questions in his mind, as he sits in the otologist's office, are numerous, but two seem to be prominent; viz.,¹ what happened to my hearing, and what can be done to help me?² By the time he has arrived there, however, these two fundamental questions have been partially answered by the patient, mostly to his disadvantage, based on knowledge obtained from family or friends, from what he has read in the lay press, and from what he has been able to pick up from the smudge-print, testimonial-packed hearing aid advertisements. He will want, however, otologic opinions on other matters, among them being: (1) What is this ringing in my ear; what does it mean and what is going to happen to it? (2) What is "hardening" of the ear bones? (3) Should the tonsils be removed? (4) Are bad or irregular teeth related to poor hearing? (5) Why can some people be operated upon for their hearing and others not? (6) Do vitamins help or will a ride in an airplane make

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it better? (7) Does trouble with hearing run in the family? and (8) Will a hearing aid make the hearing worse?

To help provide answers to these questions, we mean to examine critically the patient's needs, the otologist-patient relationship, and to suggest methods by which the adult with a hearing problem can be given an accurate, definite diagnosis, be rendered medical or surgical therapy where indicated, and be given specific, positive counseling in the channels of rehabilitation.⁴ We will consider the patient's needs in light of his reaction to the hearing loss personally, educationally, socially, and vocationally attempting thereby to provide the otologist with a means of understanding his patient and help to bring order out of chaos.

THE PATIENT'S NEEDS

Personal. It has been an observation of ours that the patient with a hearing loss delays uncommonly long before seeking expert opinion regarding his condition. The reasons for this delay should be mentioned because, in it, there are implications that are reflected in the patient's attitudes toward the otologist, to the treatment expected, and to the use of a hearing aid. In the first place it takes months or years for the patient or those around him to appreciate that there may be poor hearing present. This happens because the loss develops gradually in a person who had heard well previously, and, since there is no outward sign of disease, (pain, ache, discharge, weight loss or gain, or change in physical appearance), the impaired response to auditory stimuli is simply considered by all, including the patient, as a lapse in listening or concentration. It may be said that the patient, he himself agreeing, "had something on his mind." Such lapses in listening or concentration occur as common phenomena in normal hearing people, occupied with other thoughts which take over the cortical areas also used for auditory coordination and association. These are the occasions which call forth from each of us the exclamation, "What's wrong, are you getting deaf?" We do not, however, consider the question seriously, yet it is precisely this type of incredulity that sets the pattern for misunderstanding the patient with subtle hearing loss.

It can be seen, therefore, that a length of time must elapse before the idea of a true hearing loss can crystallize in the minds of both the patient and the people around him. In the meantime, however, as his threshold for hearing increases, the patient is exposed to numerous disconcerting experiences at home or at work. While in the plant recently, for instance, in a background of noise the foreman

called to him, as he often had done, to attend to a new task. The patient failed to hear. The foreman approached, repeated his order, and still obtained no response. Finally, when immediately behind the patient, the foreman shouted in the patient's ear, at which the patient swung around to find himself face to face with an indignant "boss," who had become offended by this unusual, and seemingly deliberate, failure to cooperate. Similar occurrences became more frequent at home, at social gatherings and lodge meetings. Here, however, embarrassment adds to the confusion and bewilderment.

Hearing some of what is said, yet missing out on other parts of conversations, he is in the middle of a baffling experience, with no signposts to guide or inform him. His personal security is threatened and he attempts to adapt his situation in ways that may be expressions of his past experience or particular psychologic "set" at the present time. He may feel that his ability to communicate with people is disturbed because:

1. Others don't speak clearly or loud enough.
2. There was too much noise at the time.
3. He has been overburdened with financial or marital troubles and hasn't been able to enjoy talking to people, going to the movies or listening to the radio.
4. He has been sick or tired and hasn't been up to par.
5. He has not been interested in talking to people anyway and prefers his own company or own recreation.
6. He hasn't ever really liked his job or his family.
7. He is losing his "grip," or his "mind," or is "getting old."

There are other adaptations to his difficulty, but, in general, his reasoning places the condition outside himself or within himself, with variations and combinations depending on the individual—and it need not be said that there are many patients who perceive and understand their hearing loss for what it is and whose reactions, therefore, are the more easily managed.

Conversations with him become struggles accentuated by frequent interruptions and embarrassments. He loses confidence in a social situation and becomes aggressive or withdraws entirely. He frequently comes to regard himself as peculiar or eccentric and moves readily into the attitudes of self-pity and antisociality. He worries about his job, or he may even be discharged for insubordination or

noncompliance as a result of his hostility. Accidents in industry, slow work, or industrial problems of a medico-legal character may arise because of his faulty hearing. If aged, he is often doomed to a lonely frustrating existence, cast aside by his family, or excommunicated from ordinary social life. It is an undramatic, crippling disability, lacking the public appeal of a crutch or a cane. None of those with handicapping hearing loss can enjoy the radio, movies, or church services. Many of them are in actual danger of being unable to hear a warning bell, the telephone, an automobile horn, or an approaching streetcar.

When the otolaryngologist understands these implications, he can appreciate his importance to the patient with disorders of hearing or speech. He must first establish an accurate and comprehensive diagnosis with all differential diagnostic possibilities considered. This entails a careful history of local otologic symptoms and diseases, as well as constitutional data of importance.

We offer an approach to history-taking in the adult in whom a hearing loss is a symptom and not a diagnosis. Questioning is to be carried out on the following basis:

A. Onset and course

1. First noticed by self or others
2. Relation to other diseases, climate or trauma
3. Gradual or sudden
4. One or both ears
5. Variations in hearing—intermittent or constant
6. How handicapping (socially or in business)

B. Tinnitus

1. Description:
 - a. Duration
 - b. Pulsating
 - c. Intermittent or continuous
 - d. Conditions which worsen it
 - e. Pitch
 - f. Comparison to other sounds
 - g. One or both ears
 - h. In ear or in the head
 - i. Psychogenic influence
2. Diplacusis

C. Dizziness or vertigo

1. Duration; relation to hearing loss
 - a. Before hearing loss
 - b. After hearing loss
2. Description of sensation or attack
 - a. Definite rotation of room
 - b. Relation to position and movements of head or body
 - c. Whether true whirling or unsteadiness
 - d. Direction of rotation
 - e. Direction of fall or tendency to fall
 - f. Sweating
 - g. Stertorous breathing
3. Severity
 - a. Nausea or emesis
 - b. Falling
 - c. Effect of closing eyes
 - d. Effect of fixing on an object
 - e. Side on which they must lie for maximum comfort

D. Discharge

1. Onset; with or without pain
2. Relation to other diseases
3. Character
 - a. Amount
 - b. Duration
 - c. Intermittent or continuous
 - d. Pulsating
 - e. Watery, pus, bloody, foul-smelling
4. One or both ears
5. Previous treatment

E. Pain

1. Location
2. Duration
3. Severity
4. Intermittent or persistent
5. Relation to chewing or yawning
6. Relation to drainage

F. Headache

1. Location and extent
2. Duration
3. Intermittent or constant
4. Nocturnal
5. Begins strong and eases up to a dull, boring type (abscess)
6. Begins dull and increases to end sharply (meningitis)
7. Relation to sensorium and other symptoms

G. Other otolaryngologic information

1. Nasal (sinus trouble)
2. Pharyngeal
3. Operative (tonsil and adenoid: nasal septum)

H. General Information

1. Allergic
 - a. Hay fever
 - b. Hives
 - c. Eczema
 - d. Asthma
2. Miscellaneous
 - a. General health
 - b. Fever, chills, malaise
 - c. Operative
 - d. Sugar in urine
 - e. Previous treatments, such as "shots" in the hip
3. Occupational, marital, etc.

I. Familial

1. Deafness
2. Other noteworthy conditions

Most patients interviewed by one of us (REM) state categorically that they are overwhelmed by a feeling of stupidity or "dumbness" when among people. This is a result of his awareness of the interpretation placed on his poor auditory response by those around him. When he is addressed and must ask that the question be repeated, the questioner invariably gives the impression that he is dealing with an intellectually inferior person. Some of the patients

avoid social activities for this reason, and understandably, since few of us can face a group knowing always that we are considered stupid. As a matter of fact, material has been gathered by us that is presented in the form of an auditory illustration (wire or tape recording) to bring out vividly the interview which we are discussing. Space does not permit the inclusion of this interesting material which to an audiologist is as informative as a histologic slide.

At about this time, or perhaps somewhat earlier, the patient becomes aware of the ringing or buzzing in his ears. This development helps to compound his bafflement and, depending upon the patient's interpretation of the ringing or buzzing, becomes either another indication of the mental deterioration he has feared, or is more evidence of the brain tumor, cancer or syphilis he had worried about for years. Added to the tinnitus in some patients is the subjective sensation of vertigo and it, too, crowds them with the general impression, already well-established, of disorientation and the feeling of profound change taking place in his blood or in his brain.

Social and Family. Notwithstanding the stress presently placed upon him by his own reactions to the mystery of hearing loss, the tinnitus and the vertigo, he must live in a world where a premium is placed on the possession of a perfectly functioning conducting and perceiving mechanism. With the exception of reading alone, the pursuit of certain hobbies, or the enjoyment of a few recreations, such as fishing, all other social activities revolve around good hearing and intelligible language. Individually we more or less depend on movies, television, radio, telephone, musical instruments, alone or in orchestral combinations, singing, or just talking with one another for productive and enjoyable living. These things have often been emphasized and are easily understood.

But what is not well appreciated is the intimate family and social relationships that are pushed out of kilter by a change in hearing acuity. In these relationships good hearing is used to pick up information which is then a basis for action or speech to control and manipulate the immediate environment. To illustrate, we might mention the difficult position of the mother who is spoken to by one of her children. The child would like to have something or would like to do something and needs his mother's understanding or assent. She does not hear him, although she may "hear" him improperly. He sees that she does not respond. He repeats himself. She still does not hear. Finally he quits in disgust, sympathy or pure resentment. She has been unable to pick up necessary information through her ears and is then made powerless to control, manipulate, or understand

her family. A similar situation can be cited for the husband who fails to hear his wife. She needs to discuss matters of importance with him but she finds him not a help but in reality a "dumb" obstacle. It is the enervating effect of the inability to utilize information through hearing in the small social group that does more to break down the resistance of the individual than any other single thing. A man can lose his job, his confidence, his health, but if somehow he is cut off from the supporting influence of his family and friends, he is close to disintegration as a human being.

Vocational. The position of the patient with a hearing loss in his profession or job is rather well known. The difficulty in understanding spoken orders or of receiving auditory information is apparent and understandable. What is not as apparent is that people with hearing loss, as compared to all other types of handicapping diseases, are the most easily placed in vocations. There is no need at this time to list the numbers of jobs and professions available to the patient with hearing loss, depending on the type and profundity of loss. It should be kept in mind, however, that every employed or self-employed patient with a hearing loss is extremely fearful of being non-productive because of his handicap. To him, hearing loss and the hearing aid means deafness and deafness means "you can't hear anything." Unfortunately, many employers feel the same way about it, and, it might be added, many physicians divide otologic disorders into two types, those that do not impair hearing and those that make their patients deaf. It would be well for all to remember that hearing loss covers the spectrum from threshold hearing on the one hand, to complete cochlear ablation on the other, but that the tremendous majority of hearing problems are placed in the middle area.

If all these factors, the personal, social and vocational, are contributing to the stew in which the patient finds himself, it may be realized that these have an important bearing on his attitude toward his disability and how he will react to what the otologist has to offer. In the first place, the mystery of the presence or absence of hearing loss causes the patient to delay consultation, but it also makes him reluctant, or forces him to refuse, to accept the prescription of a hearing aid. He needs "more evidence." He will, however, accept "shots" or massage or operation, or he will "shop around," looking for a way out of his bewilderment. Secondly, he may be personally aware of his hearing loss as such, but may refuse the aid because he might worry about how to manage it, as many women, do, and feel that he hears fairly well anyway and can continue "bluffing" his

way. He needs more evidence of his social incapacity before acceding to the use of an aid. Thirdly, there are those who will shy away from the hearing aid because: (a) an employer might dismiss him from his job if he misinterpreted the aid as an advertisement of deafness, (b) people would immediately see his handicap where previously he was considered physically perfect or (c) it might cause his family to treat him as a "baby" who needed their help. He does not accept readily the idea that he would have to be dependent on anybody, especially his family.

Although the temptation is great to categorize these patients, we must resist it since, when all is said and done, we must always be dealing with an individual person, reacting to a sensory loss as he would to most any crisis in life which presented itself. While some of us outwardly, by manner of dress, professional or domestic position, resemble others inwardly, this cannot easily be known by judgment of external appearance. How can we say that the fast-moving, high-tensioned executive refuses to wear a hearing aid for the reason of vanity when it might very well be his feeling that he does not actually have a hearing loss, or at least he has been unable to appreciate that he does? How can we say that the retiring, apparently indrawn housewife refuses to wear a hearing aid because she is the hermit type and prefers to live alone when it might very well be that she does not consider a hearing aid an adequate treatment for her brain tumor, or her mental deterioration? How can we say that the 40-year old man who perhaps has reacted poorly to other situations of stress in his life refuses to wear a hearing aid because he has always been "that type," when he may fear, and rightly so, the loss of his job if his employer should see him wearing an aid. There are many employers who would "fire" an employee found to have a hearing loss.

Although the reasons for refusal or reluctance to wear an aid can be categorized, these cannot be known by any other than by evaluation of the individual patient.

MEETING THE PATIENTS' NEEDS

The Concept and Technics of Rehabilitation. Because we feel that a complete rehabilitation program, whether it be designed for the paraplegic, the amputee or the hearing-handicapped, must be directed toward meeting the psychological, the social, and the vocational needs of the patient, the Speech and Hearing Rehabilitation Unit at the Illinois Eye and Ear Infirmary includes the following⁵:

1. Complete otological evaluation, employing all available fa-

cilities to establish a diagnosis and to recommend desirable, specific medical or surgical therapy. A complete physical evaluation must be carried out; establishing and following a definite routine minimizes errors of omission.

2. When specific medical or surgical therapy has been instituted for lesions amenable to such treatment and has accomplished its purpose but has fallen short of restoration of hearing to a useful level, the patient is prepared by the otologist for the rehabilitative procedures to follow. The otologist emphasizes to the patient that the technics of rehabilitation are to be considered an integral part of the treatment of his hearing loss and that they are as necessary to him with his ear disease as antibiotics would be if he had pneumonia. The patient is told that a hearing aid may be of benefit to him, but no decision would be made until further studies had been completed and Auditory Education classes attended.

3. Using electro-acoustic equipment in the sound treated room, a complete audiometric survey is done, including pure tone, speech reception, and speech discrimination testing, all of these done on the separate ears. In addition, loudness tolerance and signal to noise ratios are assessed, again on the separate ears. The completion of this entire evaluation gives an accurate estimate of the patient's ability to use a hearing aid as far as his cochlear function is concerned. It is a further delineation of the clinical diagnosis expressed in terms of actual hearing performance.

4. Unless the hearing evaluation as described indicates the impossibility of help with amplification, due to severe cochlear disease and subsequent poor discrimination score or low loudness tolerance and signal to noise ration, an ear impression is taken of the canal of the ear found to be the one to be used for the hearing aid, and sent to the laboratory for processing the individual mold. All patients, however, whether or not they are to have a hearing aid prescribed, are scheduled for the Auditory Education classes.

5. The Auditory Education classes are divided into two groups; adults between the ages of 21 and 60, and the geriatric group, over 60, up to 90 or 100, the upper limit depending on the alertness and desire of the patient to hear better. Our oldest patient so far was 88, but we expect to break that record. The classes have eight to 12 patients, are conducted twice weekly for two weeks, and consist of a series of four two-hour sessions. The topics covered in the four sessions are:

- a. Psychology of hearing loss, personal and social.

b. Anatomy, physiology, pathology of the ear as it affects hearing and treatments used.

c. Explanation and illustration of each patient's hearing loss, emphasizing the differences in hearing caused by high-tone loss, conductive changes, etc. The results of each patient's audiometric survey are charted and shown to him and the others.

d. Hearing aids, their use, abuse and maintenance, including cost of operation. In this session the function of a hearing aid as an amplifier of sound is discussed and the fact that the hearing aid does not give normal hearing is emphasized, as well as the fact that wearing a hearing aid will not solve all their problems.

The group sessions are conducted in an informal manner, with the lecturer or leader attempting to find out what the patients would like to know about each topic. The patients are encouraged to talk freely and to exchange ideas with others in the group. Our experience with these groups has demonstrated their fundamental value as a basic part of any rehabilitation program. The groups specifically provide a means for the patients to understand the mystery of hearing loss and to see their own problems mirrored in the expressions of others in attendance. They begin to lose the sense of isolation and defeat which nags at them and perhaps has overwhelmed some. They perceive that there is a way out, that the hearing aid, while not the final answer, can be worn with benefit, even with ease. We have also found the group sessions extremely informative as to individual differences in patients; and we have been able to pick out the patients whose hearing disability has isolated an occult personality disorder. These patients, occurring in the ratio of about one to ten, may even express suicidal tendencies, and they are singled out and counselled in preparation for referral to psychiatric centers.

6. After the four group sessions, hearing aid selection is completed for those patients whose cochlear function has been found adequate through the audiometric evaluation and who now are willing and anxious personally to use the aid.

7. Vocational and family guidance is given by the medical social worker. The patient can be directed to the specific place through which he may find a job suited to his handicap. The Division of Vocational Rehabilitation is utilized as well as the various agencies in the community. The family is informed of the patient's difficulty and makes plans to improve the home situation. It is in this area of vocational and family guidance that rehabilitation will

be able to perform a most valuable service to the community and to the nation. The demand for manpower will be, we are told, insatiable as we prepare for the future. The patient with a hearing loss is in all other physical respects a capable worker and when he is finished with the program of rehabilitation and can benefit from amplification, industrial placement follows. Those who cannot be benefited by amplification can still be placed when the proper job or situation can be found, after other rehabilitative measures are instituted.

The Otologist-Patient Relationship. Here we are faced with the crucial and vexing questions posed by the general physician and the otologist: Where do I fit in? How can I do these things and still pay the rent, the secretary and the automobile expenses? These same questions are asked by the general physician and the orthopedist, the pediatrician, the neurologist, the psychiatrist and in any field of medicine which must inevitably deal with the long-term effects of chronic disease. The pediatrician who finds that the child under his care has cerebral palsy cannot dismiss the child and his parents by saying, "Take him away—there is nothing more I can do." The neurologist, in dealing with the more or less permanent effects of hemiplegia following a cerebral vascular accident, cannot easily leave the bedside and close his ears to the family's request for further information as to the subsequent management. The orthopedic surgeon, closing the amputation flap, has never been able to send his patient home to sit in a wheel chair counting his blessings. As Rusk⁶ has pointed out, rehabilitation is a necessity for the millions of arthritics, hemi- and paraplegics, cardiacs, spastics, hearing and visually-handicapped. He states that rehabilitation must be considered the "third phase of the practice of medicine," prevention being the first phase, diagnosis, specific medical and surgical therapy the second. As a profession, responsible to our patients and our community, we can no longer ignore or misunderstand the necessity for rehabilitation in chronic disease.⁷

The otologist then must be source of diagnosis and specific medical or surgical treatment in ear disorders as far as the second phase of his medical practice is concerned. He should be interested in and specifically encourage the first phase, or prevention of hearing disabilities. This can best be done by his interest in hearing surveys,⁸ early discovery of remediable hearing loss in children and adults. And he fits into the third phase to the extent that he personally becomes acquainted with the technics of speech and hearing rehabilitation. If he desired to include rhinoplasty or bronchoesophagology in his

practice, he would find it necessary to obtain instruction before he would proceed. The principle in the field of speech and hearing rehabilitation is the same. He should be in a position after the diagnosis and treatment has been completed, to advise and counsel the patient for whatever specific hearing rehabilitative measures are indicated. He should tell his patient that rehabilitation is not only valuable but a necessity. If he is prepared to practice rehabilitation in his office, he should have auditory education groups available, he should provide for the psychological, social, and vocational needs of his patient, he should know hearing aids and their selection, he should know speech audiometry and its individual interpretation. If he is not prepared but would like to do these things, he may find instruction available to him by inquiry. If he does not want to practice rehabilitation, he should, after preparing the patient, refer him to the Speech and Hearing Center of his choice, but he should insist that the patient return to him for continuing otologic follow-up. The patient will appreciate and reward him for his interest and guidance.

The Surgical Restoration of Hearing. In this day of an informed public, it is quite natural that in every case of deafness regardless of the etiology, a discussion of the surgical restoration of hearing is brought into the picture. Practically every patient has seen glowing reports in the lay-press concerning the success of this procedure. He regards himself as a candidate because he does not realize that only a small percentage of the cases of adult deafness are otosclerotics to begin with, and very few out of the total are surgically acceptable cases. It is to be emphasized that no case with such borderline hearing qualifications be acceptable for surgery as is contained in "group 3" or where the otologic surgeon permits himself to be prevailed upon to operate because "the patient refuses to wear a hearing aid." Several things must be clearly understood. Just as with the hearing aid, emphasis was given to the fact that no hearing aid restores normal hearing, so should it be known that no fenestration procedure restores normal hearing. From the very latest figures of enthusiastic workers in this field,⁹ it is apparent that 60 per cent of the "ideal" cases are considered "rehabilitated" at the end of one year. It is conceivable that some of these "good" results will lose a part of their gain and be placed in a category below "rehabilitated." At the same time we should warn against the 40 per cent of "partially rehabilitated" and failures as being most difficult for the otologist to combat in the postoperative period when frustration becomes an outstanding feature or where the hearing loss has been made even greater.

For a good many years, we have counselled otologic surgeons to subject all prospective candidates for the fenestration operation to the rehabilitative procedures such as are contained in our concept of auditory education. It would seem that then the patient is better prepared to cope with the frustration and failures of otologic surgery. May we also emphasize that he is better able to accept the successful restoration of hearing if he has been properly prepared. The thought that, should the operation not be successful, an ear mold can be fitted to the operated ear or even the unoperated ear, and there is nothing to be lost by the attempt, is to be discovered. May we warn that not infrequently fitting of an ear mold to a fenestrated cavity is a rather difficult procedure. Moreover, the individual may in a small percentage of cases have a suppurative process which would mitigate against the use of an air conduction mold and necessitate employment of the rarely prescribed bone conduction. In other words we wish to emphasize that the conduct of a patient's case should not be a competitive one of stating surgery versus the hearing aid, but each individual case should be decided upon its merits.

While discussing the surgical restoration of hearing, we would be remiss if we did not mention the need in suppurative ear disease, for surgical procedures upon the ear or upon the nose or nasopharynx. It is to be emphasized that the chronic suppurative ear that has fair hearing, together with an attic perforation, often in association with cholesteatoma, is the responsibility of the otologic surgeon to prevent the hearing from becoming further impaired to say nothing of the life-endangering qualities of cholesteatoma. It seems to us that the hearing conservation is insufficiently stressed in this area and there is an unwholesome attitude on the part of the general physician that antimicrobials will be the answer to such problems.

The Patient, Hearing Aid Dealer Relationship. Inasmuch as the patients must find assistance through the use of hearing aids, it is up to the otologist to acquaint himself with the economic aspects of the instrument itself, its manufacture, its wholesale distribution, its retail sale and outlet, and upkeep problems, that is, if he desires to render a complete service to his patient. Unfortunately, from the patient's point of view, the selection of a hearing aid is based on the best advertising appeal that has been provided by the national manufacturer or by some aggressive local dealer. After all, the dealer is in business for a profit, which he should be, but unfortunately, certain unscrupulous business methods are applied to this area. Too often has the management of the case consisted of merely saying to the patient, "Well, what you need is a hearing aid." The patient is then to

fend for himself. This is where the total picture breaks down. Actually, the patient must be prepared to receive a hearing aid even before he is sent for the testing procedures which would evaluate this situation.

We were recently struck by the type of advertising put out by one hearing aid manufacturer who stressed "Hear in Secret." We thought much more of the slogan of the American Hearing Society when they said, "Hearing is Everybody's Business." A notable advance was recently made when one of the large hearing aid companies published a pamphlet for prospective hearing aid users, answering the various questions that would crop up in their minds. For example, answering a question—"Is there a hearing aid I can wear that no one will know that I am hard of hearing?" It would certainly seem that the patient who shops around for a hearing aid that he can hide, is a patient who has been without the adequate preparation of auditory education. He will be one of the thousands of patients who place their hearing aid in the dresser drawer and decide that both the otologist and the hearing aid dealer are unscrupulous, dishonest individuals. No individual who has not been given the benefit of the gradual development of tolerance for amplified sound, or no individual who has not been given the benefit of discrimination of speech sounds through amplification, or has been informed of the complete make up of the hearing aid, and taught the skills of wearing an aid, will fare very well even with the best instruments.

As was previously said, the cost of the instrument must be considered but no favoritism must be shown even though admittedly, there is not too much difference between the better aids on the market. Too often models of the hearing aid are quickly changed. This is rather unfortunate because the patient bears the brunt of the cost and the referring otologist is embarrassed. Lack of commercial stability of the dealer is frequently the source of considerable concern and a dealer who on one sale will represent one hearing aid and on another occasion have an entirely different company, frequently leaves the patient and the community no other choice other than to change aids. Inasmuch as repair and replacement is a major item such a local representation is a necessity and at times is the very reason for the final choice of a given aid. One last item might be mentioned and that is, the otologist should never allow himself to be connected with the hearing aid transaction in a business way. We have only to mention the tremendous upheaval relative to the fitting of glasses and their dispensing. Surely no reputable otologist would lend himself to such practices.

SUMMARY

The area of the deafened adult is a challenge to the otologist who is interested in offering his patient total care. We have not attempted to cover in detail the fascinating fields of speech and hearing rehabilitation and audiology, but have emphasized the need for a study of the person who seeks aid for the amelioration or cure of his hearing deficit. There was a time in the not too distant past when the patient was subjected to the trial and error method of inflations of the middle ear regardless of the preponderance of nerve degeneration or the objective failure of improving the hearing; a submucous resection of the nasal septum when the passage of a eustachian catheter was difficult, in spite of the fact that inflation could be accomplished through the unobstructed side; a tonsil and adenoid operation for reasons that would obviously constitute a stretch of the imagination and a series of radium applications that merely added to the frustration on the part of the patient whose mixed deafness failed to respond to vitamins, histamines, prostigmine or the myriads of other remedial agents which have at one time or another raised high hopes for success.⁹ When all these measures have failed and the patient queries, "What next?" or simply tires of the approach to his problem, he is too frequently shunted along on his way to fend for himself or with the feeling that he has consulted the final authority and now all is lost. The modern approach to the problem calls for the highest ethical and moral responsibility on the part of the otologist and not solely the educator's in bringing to the patient the advantage of the latest procedures.¹⁰

What are the employed procedures? They include intelligibility testing to determine the extent of word discrimination possessed by the patient and also to evaluate the improvement in discrimination made possible with amplification in the presence of standardized noise. In addition, the selection and evaluation of hearing aids involves an inventory of all tests previously noted, such as voice tests, a study of the person who seeks aid for the amelioration or cure of tuning fork tests, pure tone audiometry, speech reception tests, and the trial of a number of hearing aids under the same environmental conditions. No hearing aid restores normal hearing; it is, at its best, an aid. There is more adjustability present in the patient than in the hearing aid. He is taught as a hard-of-hearing person who wears a hearing aid and not as a normal person having to wear an aid. The patient receives a hearing aid selection under objective conditions in the sound-treated room and with his personal ear mold. A course in auditory education is given preparatory to the actual selection of the aid. In such a course he receives knowledge about

his personal hearing loss; he is conditioned in the development of tolerance for amplified sound with explanations about psychologic effects of hearing loss (in group therapy principle), some instruction in speech reading and the use of auditory clues, and instructions in methods of practice at home and aid in the adjustment to life situations. He receives a psychologic survey, more detailed at the psychiatric center if necessary. For vocational and educational considerations in acquiring new skills, he is directed to local or state agencies concerned with the necessary type of counselling.

How is this complete hearing and speech rehabilitation program to be supervised and achieved in actual practice? It is necessary, first of all, for the otolaryngologist himself to be educated in these procedures. Such education may be obtained at several rehabilitation centers in various university clinics where young otolaryngologists-in-training are already finding teaching available in clinical rehabilitation and its related basic science, audiology. After the otolaryngologists in practice has been adequately informed about rehabilitative procedures, what does he do then? It depends upon where he practices. In the larger metropolitan areas, hearing centers for clinical rehabilitation already exist. Patients may be sent there for retraining, hearing aid selection and counselling. The family and the community have failed to answer the needs of the deaf and the hard of hearing—the family through lack of understanding of the person with the handicapping loss, and the community without realizing the economic load of improperly educated and trained members of its group. The physician may likewise be remiss in his duties if he fails to arouse the family and the community to the needs.

We have attempted in this brief presentation to call attention to the major needs of the adult deafened individual and direct the major role for responsible care to the otologist. It is to be anticipated that his increasing interest in the problem will go far in the management of adult hearing deficits.

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XIII

RHABDOMYOSARCOMA OF THE MAXILLARY SINUS

REPORT OF A CASE

REVIEW OF THE LITERATURE

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Striped muscle tumors, benign and malignant, and variously designated as rhabdomyoma, myoblastosarcoma, rhabdomyosarcoma, myoblastoma, malignant rhabdomyoblastoma, and myoma, are very rarely encountered in the nasal and paranasal sinus regions since no cross striated muscle cells exist here. Ringertz¹ found none in his 391 cases of nasal and paranasal tumors and only six in the literature up to that time. Two of these he believed to have originated in the facial musculature. Berenati² in his 64 cases of tumors of the nasal cavity found no striped muscle tumors. In view of these observations it is believed that the following report of a tumor of the maxillary sinus, histologically diagnosed as a rhabdomyosarcoma, will be of interest.

REPORT OF A CASE

The patient, a boy aged 12, was admitted to the hospital on April 13, 1950. The mother stated that in October, 1949, the right eye became bloodshot and the skin area beneath the eye inflamed. Ice was applied and the eye apparently returned to normal. There was no history of pain. Ophthalmologic examination, including perimetry, brought out no pathologic findings, and eye drops were prescribed. A second eye examination two months later revealed no abnormal features. At this time a neurologic examination reported only increased nervous tension. The family physician advised x-ray examination of the sinuses and the boy was admitted to this hospital to the Ear, Nose and Throat Service. Functional inquiry brought out the following points. The patient's appetite had been good until a week previous to admission when he complained of abdominal pain of vague character. There had been no vomiting, no fever, and no

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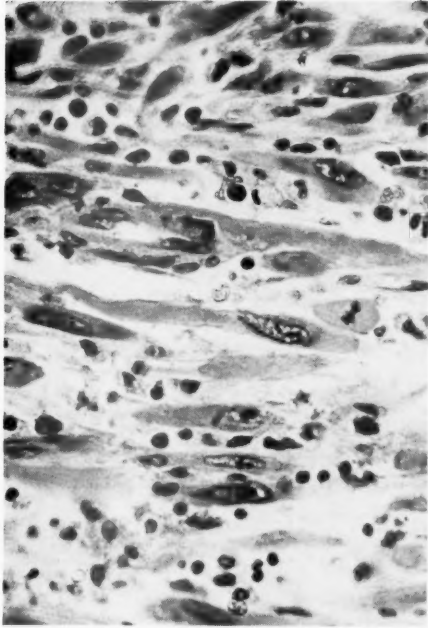


Fig. 1.—Photomicrograph showing long strap cells with the nuclei containing prominent nucleoli. These cells suggest imperfectly formed muscle cells.

weight loss. He complained of having had pain in the right upper teeth for several weeks but dental examination brought out no positive findings. There had been no epistaxis, no cough or pain in the chest. The lungs were clear to auscultation and percussion; the heart action was normal.

Among the ocular symptoms a mild diplopia at a distance had been present for from one to two months. There was some blurring of vision in the right eye, with impairment of color perception. For the past six months slight protrusion of the right eyeball had been noticed. Visual examination was 20/30 in the right eye, 20/15 in the left eye. Exophthalmometer reading was 16 mm in the right, 15 mm in the left eye. The right eye was displaced upwards about 5 mm. The extra-ocular muscles were intact and there was no diplopia in any field. The pupils were equal and reacted to light and accommodation. Ophthalmoscopic examination revealed clear media and normal fundi. The foveal reflex was equal in both eyes.

Examination of the nose showed the right nostril to be obstructed by edema and displacement of the turbinates toward the septum. No pus was seen in either nostril. Transillumination showed the frontal sinuses to be clear; the right antrum, dark. Adenoid tissue in the nasopharynx was moderate in amount. The tonsils had not been removed. There was no enlargement of the cervical nodes.

On admission to the hospital x-ray examination of the nasal accessory sinuses revealed an expansion of the right maxillary antrum with upward displacement of the inferior rim of the orbit and apparent destruction of the bony walls of the lateral portion of the antrum. The entire sinus was opaque. All other sinuses were essentially normal in appearance. The sella turcica was normal in size and configuration. The appearance of the right antrum was consistent with the presence of a neoplasm.

Blood serology was negative; hemoglobin 78 per cent; RBC 3,880,000; WBC 11,900; polymorphonuclears 70 per cent; lymphocytes 23 per cent; monocytes 6 per cent; eosinophiles 1 per cent.

Urinalysis: S.G. 1.018; alkaline; albumin and sugar negative.

On April 18 under general anesthesia the right maxillary sinus was entered through an opening in the canine fossa. A tumor mass and purulent exudate under pressure were encountered. The tissue was grayish yellow, friable and partly necrotic. After thorough removal of the tumor with curettes, dehiscences were found in the bony wall superiorly and medially, the bony nasoastral wall being almost entirely eroded. The membranous portion of the nasoastral wall including the inferior turbinate was removed. The astral cavity was packed with iodoform gauze and the original incision in the mucous membrane closed with interrupted silk sutures. The postoperative course was uneventful.

X-ray therapy was begun on the eighth postoperative day. Right and left portals were used and a third was directed over the right antrum. At the end of treatment each lateral portal had received 1300 r in air and the direct astral portal 1800 r.

At the last examination five months later the slight protrusion of the right eye had cleared. Examination of the astral walls with the nasopharyngoscope showed no evidence of local recurrence.

Pathological Report. Gross specimen consists of numerous irregularly shaped tissue fragments which are friable, granular and aggregate approximately 5 cc. Received in Zenker's solution which obscures gross characteristics. Microscopic sections show the tissue

to be composed of whorls and bands of spindle shaped, darkly staining cells which vary greatly in size and shape and are closely spaced with little or no intercellular material. Vascularity is marked and lymphocytes infiltrate diffusely.

In many zones the tumor cells assumed bizarre shapes with long cytoplasmic processes and multiple nuclei. In many instances the cytoplasm is granular or vacuolated. Some cells are elongated and contain several nuclei spaced at intervals. Many nuclei are rod-like and resemble those of voluntary muscle. Still other cells have a tad-pole shape with long broad tail-like cytoplasmic processes. Portions of the tumor are necrotic.

Phosphotungstic and hematoxylin stains fail to reveal striations in the cells.

Diagnosis: Rhabdomyosarcoma of right antrum.

Dr. Andrew A. Eggston concurred in this diagnosis.

NOMENCLATURE

Much confusion exists regarding the nomenclature of these tumors. Abrikossoff³ recognizes four types:

1. Tumors with myoblasts with no cross striations—the pure myoblastoma.
2. Myoblasts similar to the above but with striations.
3. Tumors with hypertrophic myoblasts often multinucleated and of syncytial type, striation present in some but absent in many.
4. Atypical myoblastic sarcoma. A polymorphous celled tumor in some areas frankly sarcomatous, in others showing less undifferentiated cells with well defined longitudinal and cross striations.

Abrikossoff³ emphasized that those muscle tumor cells which he designated myoblasts might show longitudinal or cross striation but might be entirely devoid of any such manifestation.

Rakov⁴ adopted the term malignant rhabdomyoblastoma for tumors consisting of immature striated muscle cells showing infiltrating destructive growth and having the capacity to metastasize. He believes the terms myosarcoma and rhabdomyosarcoma imply that the tumor originates in mature striated muscle cells and that these terms are therefore not correct. He classifies the tumors as immature rhabdomyoblastoma and mature rhabdomyoblastoma. The latter type has cross striations while the former has not. He notes that metas-

tasis is rarely observed in regional nodes and that distant metastasis is frequently noted. Rakov analyzed 17 muscle tumors which he termed rhabdomyoblastoma. In only six were all characteristic features present. In nine cases cross striations were lacking. Despite this, he classified them as rhabdomyoblastoma.

Cappell and Montgomery⁵ divide these tumors into two groups. Group I consists of those tumors showing well defined cross striations and further subdivided into (a) simple rhabdomyoma composed of well differentiated muscle fibers; (b) malignant rhabdomyoma or rhabdomyoma sarcomatodes, a pleomorphous round and spindle cell sarcoma showing well defined cross striation in at least a small proportion of the cells. Group II consists of tumor cells the staining reactions of which are those of muscle cells and which morphologically resemble myoblasts of spindle cell and the so-called hypertrophic type. These cells may be non-striated or they may show very delicate striations detectable only by a special technique. These authors suggest that the term myoblastoma be used only for tumors originating in striped muscle but practically devoid of cross striations.

ETIOLOGY

McCallum⁶ noted that in children these tumors commonly occur in the heart wall, the bladder and vagina, the kidneys and the esophagus. He emphasized that most authors believe that they arise from a rudiment derived from an early embryonic stage which, becoming displaced in the course of development, have grown in unusual situations.

In emphasizing the embryonal character of the rhabdomyoma, Ribbert⁷ and Roskin⁸ noted the gradual transformation of undifferentiated round cells into longer branching cells and later into larger cells with fibrils.

Ewing⁹ stated that it is probable that many of these cellular tumors in children arise from embryonic disturbances and possibly from embryonal cells, while in adults the great majority of tumors arise from adult muscle cells.

In the case reported here the tumor is believed to have originated within the maxillary sinus in spite of the early symptoms being referable to the eye. Since cross striated muscle cells do not exist in the nasal and paranasal mucosa, its origin is assumed to be from misplaced embryonic muscle cells.

INCIDENCE

In 1908 Vail¹⁰ reported a rhabdomyoma in a 58 year old woman with a six weeks' history of difficulty in nasal breathing on the

left side. Transillumination of the sinuses was negative. The growth originated in the choana. The tissue was examined by Dr. William H. Welch. The tumor recurred shortly and invaded the left antrum and nasoastral wall. Death occurred a few hours following the second operation.

Reitter¹¹ reported the case of a girl, aged 14, with a swelling over the left side of the nose following a blow from a baseball bat eight months previously. The tumor grew rapidly. Biopsy showed irregular bundles of fibers closely resembling those of striated muscle. Each had a distinct sarcolemma, and cross striations were visible. No mitotic figures or other evidence of malignancy were visible. No surgical procedure was permitted and no follow up is reported.

Martin and Alexander¹² described the case of a girl six years of age who had a constant nasal discharge, difficulty in breathing and discharge from the left ear. When a routine tonsillectomy and adenoidectomy was performed, a mass was found in the nasopharynx unlike adenoid tissue. The tumor was diagnosed as a rhabdomyoma. Local recurrences developed, including the posterior choana, the left maxillary antrum, and cervical nodes. Although a tracheotomy had been performed the patient died from compression of glandular masses in the neck.

Cooper¹³ had a man, aged 67, who complained of pain in the left side of the face, occipital headache, diplopia, and impairment of hearing in the left ear. He first noticed swelling at the inner canthus of the left eye, difficulty in breathing through the left nostril, and epistaxis. The swelling increased in size, proptosis of the left eye and diplopia developed, and there was evidence of Horner's syndrome. A red fungating mass was found in the left nostril. The pathological diagnosis was malignant rhabdomyoma of the paranasal sinus. Cooper was of the opinion that the tumor had arisen from the internal pterygoid muscles as these muscles, together with the posterior wall of the antrum, were completely destroyed. Dr. A. C. Broders of the Mayo Clinic concurred in this diagnosis, stating that the tissue resembled rhabdomyosarcoma. Dr. James Ewing disagreed; he believed it to be an atypical form of cancer.

Reese and Calhoun¹⁴ reviewed the literature up to 1941 and found 14 striated muscle tumors in the lid and orbit which were clearly defined rhabdomyosarcoma. They also reported five cases of their own, all in children. Of the five cases two have shown no sign of recurrence two years following exenteration of the orbit and more than three years after the appearance of the tumor. One case

showed no sign of recurrence one month after exenteration of the orbit. One patient died five months after exenteration of the orbit.

Schall and Cordray¹⁵ reported a rhabdomyoma in a boy aged six who suffered from nasal obstruction although a tonsillectomy and adenoidectomy had been performed a year previously. The tumor, which had originated from the posterior border of the septum, was removed surgically but recurred in spite of external radiation. At a second operation the entire nasal septum was removed. Later, two lateral rhinotomies for recurrences, combined with maximum dosage of radiation, was the treatment employed. The child died from cervical, pharyngeal and mediastinal metastasis.

Nicory¹⁶ reported a pedunculated rhabdomyoma of the uvula in a five year old girl. Microscopically the tumor showed finely granular sarcoblasts passing into slender tapering fibers of a highly cellular sarcomatous basis. Seven months later a recurrence of the growth had invaded the greater part of the soft palate. Subsequent history is not recorded.

Karatay¹⁷ has recently reported a case of rhabdomyosarcoma of the middle ear. A three year old negro girl was admitted to the hospital with paralysis of the left side of the face and slight bleeding from a tumor in the left external auditory meatus of five days' duration. Two biopsies reported granuloma. A radical mastoidectomy was performed and the mastoid antrum and middle ear were found to be filled with a tumor which seemed to originate from the anterior part of the middle ear. Tissue from the adenoid region was reported as not containing tumor. Roentgen therapy was instituted following the operation. The tumor recurred rapidly. Paralysis of the left 6th and 7th nerves of a peripheral type developed and questionable paralysis of the 12th. The child died about five months later. Post mortem examination showed extensive involvement of the radical cavity, destruction of the bony base of the middle cranial fossa on the left and extension of the tumor into the neck, together with destruction of the adjacent portion of the sphenoid bone and left orbit. The petrous pyramid was destroyed and the growth had extended also to the cerebellopontine angle and the pharynx.

Cappell¹⁸ reported a case of malignant rhabdomyoma in a ten year old girl. The tumor was a nodular, fleshy growth the size of a walnut, suspended by a short stalk from the soft palate. It was removed with a snare. After three years there was a recurrence and again nine months later, at which time the soft palate, the left tonsil and the left posterior pillar of the fauces were involved. The tumor was removed by diathermy and radium was applied. There was a

recurrence nine months later. Fourteen months following this recurrence the patient was admitted with a flaccid paralysis of the lower limbs and signs of compression of the spinal cord. Cervical nodes were enlarged and pulmonary consolidation was present. Death occurred seven years after the original diagnosis. Microscopic examination of the original tumor revealed well formed small fibers with transverse striations, areas of spindle cells, and also highly anaplastic round cells. In the recurrent tumor a similar histologic picture was maintained, with increasing areas of anaplasia. In the metastasis in the glands and the lungs the structure resembled a large round celled sarcoma with practically no differentiation.

Soderburg's case¹⁹ was that of a seven year old boy with a bloody discharge from the left ear, diagnosed as acute otitis media. The boy had a left sided peripheral facial palsy with a marked horizontal and rotary nystagmus to the left. He was completely deaf in the left ear. The exterior auditory canal was filled with polypoid masses of pale tissue. Biopsies on two occasions reported the tissue to be non-malignant. A mastoidectomy was performed and the mastoid cavity was found to be filled with granulations. A few days following operation the patient had epileptic seizures with periods of unconsciousness. The dura was exposed over the posterior fossa on the left side and found to be bulging. No pus was obtained. The patient died three days later. At autopsy a grayish yellow tumor was found enveloping most of the left hemisphere of the brain. The primary site of the tumor was the epipharynx where a lobulated gangrenous mass projected toward the choanae without invading or obstructing the nasal cavities. Although the histologic picture was that of a benign rhabdomyoma, the metastatic deposits in the lungs and on the surface of the diaphragm indicated rhabdomyosarcoma.

HISTOLOGIC DIFFERENTIAL DIAGNOSIS

Microscopically, striated muscle cell tumors show extreme polymorphism. There are present (a) elongated spindle shaped cells of varying size, either lying parallel or arranged irregularly in bundles, often with large, occasionally multinucleated nuclei and a cytoplasm which is acidophilic and granular; (b) large polyhedral cells with single nuclei and abundant cytoplasm; (c) small round cells with compact nuclei; (d) giant cells of various sizes and shapes; some of these are spindle shaped cells with hyperchromatic nuclei; (e) fibrils, seen chiefly in the long spindle shaped cells showing both longitudinal and transverse or cross striations. It is these fibrils particularly that determine the origin of the tumor.

Cappell¹⁸ believes that many of these striated muscle tumors have not been recognized or have been designated myomas or merely sarmocas. Reese and Calhoun¹⁴ concur with this belief and state that with improved staining and preparation of sections some of the spindle and round-celled sarcomas may be found to be in reality rhabdomyomas. In this regard Marin and Alexander's¹² observation on their patient with nasopharyngeal rhabdomyoma is of interest. Sections from the original tumor revealed spindle-shaped and true myogenic cells with longitudinal and cross striations. When the recurrent tumor was examined five months later a more aberrant structure was found in microscopic sections. The authors suggest that had not the original sections been so definitely of muscle cell origin the tumor might have been diagnosed as a spindle-celled sarcoma.

CLINICAL FEATURES

Because of the rarity of tumors of striated muscle origin the literature contains little discussion of their clinical features. It is mainly concerned with the histologic characteristics. Rakov⁴ noted that the immature types with predominance of small spindle-shaped cells show rapid growth whereas the mature types with large spindle-shaped cells and giant cells grow more slowly and metastasize late.

Early and frequent recurrence locally is a significant characteristic of these tumors.

Metastasis by way of the lymph nodes is not commonly observed. Distant metastasis by vascular and lymphatic routes to the lungs, pleura, pericardium and ovaries has been reported more frequently. These tumors are more common in children and adolescents but occur in all age groups.

TREATMENT

Thorough surgical removal of the tumor followed by x-ray or radium therapy has been the treatment of choice. X-ray therapy alone and in combination with surgery has, however, been of extremely limited value. All five of Reese and Calhoun's¹⁴ cases received preoperative radiation. In only one case did they report temporary regression for 15 months. Rakov⁴ reports no benefit from radiation in ten of the 15 cases he operated upon. In five of the ten cases radiation was given preoperatively and in five, postoperatively.

SUMMARY

A rhabdomyosarcoma originating in the maxillary sinus in a 12 year old boy is reported. The literature contains only rare reports of these striated muscle celled tumors in the field of otolaryngology. It is believed, however, that with more careful observation and study of pathologic material many more tumors designated as round and spindle-shaped sarcoma may in reality be rhabdomyosarcoma.

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XIV

MALIGNANT MELANOMA OF THE LARYNX

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Malignant tumors of the larynx other than carcinoma are rare.¹ Metastasis to the larynx from malignant tumors in other parts of the body is almost unknown. The following case is that of a malignant melanoma, probably metastatic, involving the left true vocal cord.

REPORT OF A CASE

A white, American born, railroad engineer, aged 68, entered the hospital on June 26, 1951, complaining of increasing hoarseness of five months duration. Two weeks before admission he became aware of a mass in the right axilla that rapidly increased in size. He had lost 20 pounds during the last year. The family history was non-contributory. His past history revealed a diagnosis of diabetes mellitus first made in 1941. The disease was adequately controlled by diet. Physical examination findings were as follows: On admission the patient's temperature was 98.6, his pulse 84, blood pressure 130 mm Hg. systolic and 88 mm diastolic. A rather soft smooth non-tender mass, 6 cm in diameter, and fixed to the deep structures, was noted in the right supraclavicular region. A firm, smooth, slightly tender mass, 12 cm in diameter, was noted in the right axilla. Indirect laryngoscopy revealed a pedunculated greyish-pink tumor, six mm at its widest diameter attached to the under surface of the middle one-third of the left true cord. The tumor moved back and forth between the cords on respiration. Laboratory data revealed that the urine had a specific gravity of 1.017 and contained 2+ sugar. It was later found to be negative for melanin. The hemoglobin was 93% of normal. The WBC count was 5300 with 11 stabs, 47 segs, 30 lymphocytes, nine monocytes and three eosinophils. The Kahn was negative. A fasting blood sugar was 136 milligrams per cent. Roentgenographic studies revealed a two centimeter area of radiolucence in the right occipital bone compatible with a metastatic lesion. A soft tissue mass later developed in this area.

From Veterans Administration Hospital, Jefferson Barracks, Missouri.

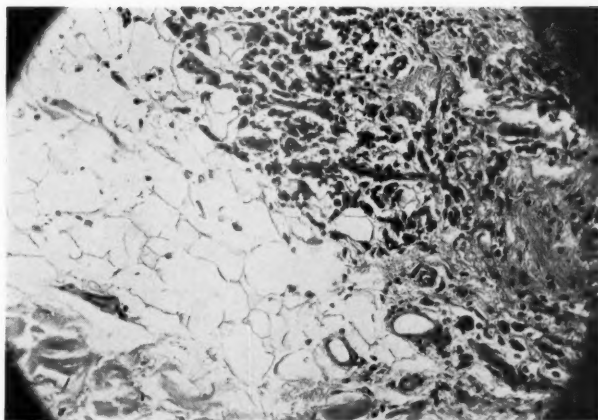


Fig. 1.—Photomicrograph of malignant melanoma of the skin invading the subcutaneous tissue. x 250.

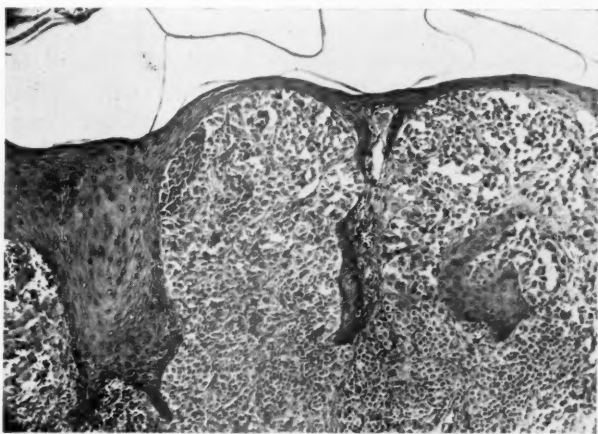


Fig. 2.—Photomicrograph of malignant melanoma of the left true vocal cord. x 250.

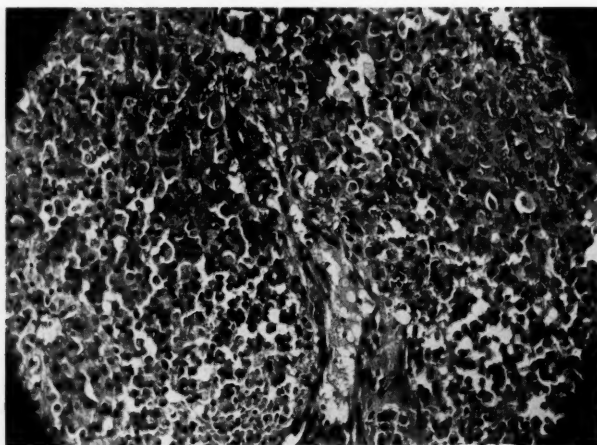


Fig. 3.—Photomicrograph of malignant melanoma of the right axillary lymph node. $\times 250$.

The patient's diabetes was controlled by diet. The vocal cord tumor was removed under direct laryngoscopy on June 30, 1951. A section of the tumor showed invasion of the laryngeal mucosa by sheets and nests of anaplastic cells of a polygonal shape. Many cells contained a granular brown pigment. The cells compressed the overlying stratified squamous epithelium but did not appear to originate from it. Pathological diagnosis was: Larynx, malignant melanoma, probably metastatic.

Following this diagnosis the patient's skin was closely examined and a blue-black, slightly raised, 8 mm area was found in the intra-scapular region to the right of the midline. This was excised and a microscopic section showed invasion of the dermis by irregular, loosely arranged nests of large oval, round, stellate and occasional spindle shaped cells. The cytoplasm of these cells was loaded with coarse granules of dark brown pigment. The nuclei of most of the cells were completely overshadowed by pigment. In one area the cells invaded the subcutaneous fat. Pathological diagnosis was: Skin of back, malignant melanoma.

A lymph node from the right axilla showed complete destruction of its architecture as a result of invasion by nests and cords of large highly anaplastic cells. The cells were loosely arranged and varied from oval to stellate to spindle forms. A few of the cells con-

tained granules of a dark brown pigment in their cytoplasm. Occasional mitoses were present. Large areas of necrosis were scattered throughout the node. Pathological diagnosis was: Lymph node, axillary, malignant melanoma, metastatic.

When the patient was last seen, on October 10, 1951, the supraclavicular and axillary masses had increased in size. There had been no recurrence of the laryngeal lesion.

COMMENT

In this case the skin lesion represents the most likely primary site of the malignant melanoma. A search of the world literature from 1916 through 1951 revealed two other cases of malignant melanoma involving the larynx.

Havens and Parkhill reported a case of a 48 year old male who came to the Mayo Clinic complaining of a sense of irritation in his throat of one year's duration. On examination a dark brown mass was seen arising from the right arytenoid cartilage. A biopsy was taken and a diagnosis of malignant melanoma was made. There was evidence of wide spread metastasis of the tumor at this time. They presumed the laryngeal lesion to be the primary site of the origin of the tumor.¹

Fisher and Odess recently reported a case of malignant melanoma in a 63 year old white female in which two years after the onset of the primary disease involvement of the larynx occurred. On examination of the larynx a rounded, smooth, dark colored tumor involving the entire right true vocal cord was noted. Biopsy was reported as metastatic malignant melanoma.²

SUMMARY

A case of malignant melanoma probably metastatic involving the left true vocal cord is presented. A review of the world literature from 1916 thru 1951 revealed only two other cases of malignant melanoma involving the larynx.

Malignant melanoma of the larynx is apparently of rare occurrence. It is suggested that in the future such cases be reported until a suitable series is available in the literature for study.

This paper was reviewed in the VA and published with the approval of the Chief Medical Director. The statements and conclusions published by the author are the result of his own studies and do not necessarily reflect the opinion or policy of the VA.

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XV

PROGRESS IN THE SURGICAL TREATMENT OF BILATERAL LARYNGEAL PARALYSIS

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Bilateral recurrent laryngeal paralysis, clinically known as bilateral abductor paralysis of the larynx, occurs with relative infrequency. Nevertheless, the subject has become particularly intriguing to the laryngologist during the last decade because of the surgical measures devised for the correction of this deplorable condition. Certainly the often extreme handicap to which the patient is subjected stimulates remedial effort, and the sincere gratitude of patients who are afforded relief is like none encountered among other groups. The subject is important also because the condition may be overlooked and is not well understood by many physicians and surgeons, as Jackson¹ recently observed. In addition, it is dangerous if it is not diagnosed promptly and treated properly. Respiratory infection, for example, may increase obstruction of the airway sufficiently to cause asphyxiation, or, if the paralysis is not taken into consideration, the patient may become asphyxiated if subjected to anesthesia.

The proclivity of the abductor muscles of the larynx to become affected in lesions of the recurrent laryngeal nerve or in central lesions has been known since Semon² published his masterful treatise on motor disturbances of the larynx in 1881. Unanimity of opinion, however, regarding the innervation of the larynx is lacking, but, according to Clerf,³ the views expressed by Onodi are widely accepted. These are that all the muscles of the larynx except the cricothyroideus are innervated unilaterally by the corresponding recurrent laryngeal nerve. The arytenoideus, an unpaired midline muscle, is supplied by both right and left recurrent nerves. The cricothyroideus is supplied by the corresponding external subdivision of the superior laryngeal nerve. It follows then that the muscles supplied by the recurrent nerves primarily control the threefold function of the larynx: air exchange, sound production and defense against the entrance of substances other than gases into the lungs.

Presented as a candidate's thesis to the Amer. L. R. & O. Society.

As every surgeon knows, the course of events following peripheral motor nerve paralysis differs in no way from that in all motor nerve paralyses. There is at first flaccid paralysis of the muscles with loss of power to contract; then follows atrophy, fibrosis and contracture. So it is in the larynx. The term bilateral abductor paralysis of the cord fails to take into account the full extent of the condition prevailing in the larynx for with paralysis of the recurrent laryngeal nerve, paralysis of all the intrinsic muscles of the larynx, the dilators, constrictors and tensors is implied. Accustomed to examining the vocal cords, the surgeon is prone to forget the other structures.

When both recurrent nerves are injured, there is immediate loss of voice and loss of the defensive mechanism. Initially, air exchange may or may not be seriously disturbed, depending upon the position of the cords immediately following paralysis. Terms used to designate the position of the paralyzed cord appear to be needlessly complicated. Despite reference to median, paramedian, mid, adductor, abductor, phonatory, intermediate and cadaveric positions, there are obviously but three positions for the cord to assume: (1) immediate adduction or midline position; (2) immediate abduction or extreme opening of the paralyzed cord; and (3) the intermediate position about midway between abduction and adduction, commonly called the cadaveric position.³ Included in this third group are approximately 90 per cent of all vocal cord paralyses, whether unilateral or bilateral.⁴ Upon assuming a more or less modified cadaveric position, the cords are in a very relaxed or flaccid state. The tendency is for the cords to be sucked into the cricoid ring and to obstruct partially the inflowing air current. The extent to which the cords and the conus elasticus are sucked into the ring of the cricoid cartilage determines the degree of obstruction.⁵

INCIDENCE

This distressing condition has been reported to be more common in men than in women and rare in children.⁶ Recently, however, Clerf⁷ reported a series of 66 cases in which 56 patients were women, nine were men, and one was a boy aged 14 years. The oldest was 76 years of age, and more than half were over 35 years old. Abductor paralysis is reportedly not uncommon in the newborn, but often overlooked.⁸ Pearlman and Leshin⁹ reported a case of bilateral abductor paralysis of the vocal cords requiring tracheotomy, with recovery, in a 2 day old infant.

ETIOLOGY

Rarely is disease of the larynx a cause of paralysis of a vocal cord. Peripheral lesions are responsible in approximately 90 per cent of the cases, with the causes classified as mechanical, traumatic, neoplastic, inflammatory and idiopathic. Disease of the central nervous system accounts for the remaining ten per cent.^{3, 8}

In cases of peripheral origin, trauma, surgical or nonsurgical, is frequently observed. The commonest cause of bilateral recurrent laryngeal paralysis is trauma resulting from thyroidectomy. There may be injury of the recurrent laryngeal nerves at operation; they may be incised, pinched, clamped or included in a ligature, or torn loose where they enter the larynx. Also, they may be injured post-operatively by hemorrhage, swelling or scar tissue formation. The commonest type of recurrent nerve injury is to the trunk of the nerve before its division into anterior and posterior rami, thus paralyzing adductors, abductors and constrictors of the larynx.⁴

In a series of 61 cases of paralysis following thyroidectomy reported by Clerf³ in 1947, the condition occurred bilaterally in 33 and in 21 tracheotomy was required for dyspnea. In 1950, this author reported having operated on 66 patients, in 60 of whom the paralysis followed one or more thyroidectomies. In 34 of the 38 cases reported by Jackson,¹ the bilateral paralysis occurred as a complication following thyroidectomy. Woodman¹⁰ reported a series of 24 cases, in 21 of which the bilateral paralysis followed thyroidectomy.

In addition to trauma, numerous other causes are mentioned in the literature, ranging from syphilis,^{1, 11} malignant tumors³ and arteriosclerosis¹ to pulmonary tuberculosis,⁷ arthritis,¹² measles⁷ and "moonshine" whisky.¹³ The etiology remains obscure in approximately ten to 12 per cent of cases of paralysis of the larynx.³

SYMPTOMS

Whatever the cause, bilateral abductor paralysis of the larynx is of grave import and may cause sudden death by asphyxiation. The outstanding symptoms are dyspnea and inspiratory stridor, which are present in varying degrees. Some patients experience dyspnea only on exertion, and others are dyspneic and have stridor more or less all the time. It may be that these symptoms are manifest even before the patient leaves the operating table. Tracheotomy may be necessary immediately following the injury to prevent suffocation. Obstruction, however, generally is not sufficient to require tracheotomy, but is characterized by inspiratory stridor and complete loss

of voice except for a whisper, which is not a laryngeal sound. At first relaxed in the cadaveric position, the cords are drawn closer together as fibrosis and contractures take place. In consequence, a period of six months to a year may elapse between paralysis and pronounced obstructive dyspnea. King,⁵ in 1941, observed that in the past about half of the persons so affected had permanent tracheotomy and the others were largely chronic invalids. He described the sequence of events in the average case as follows: "immediate loss of voice, stridor, difficulty in swallowing—especially fluids, improvement in capacity to swallow, temporary improvement in stridor. In a few months the voice begins to return, dyspnea begins to develop. As the voice improves, dyspnea is intensified. Stridor gradually returns with improvement in the voice. It becomes so loud during sleep that many of the patients are social outcasts."

Diagnosis as a rule should not be difficult. Ulvestad and Boies⁸ reported that spontaneous recovery, usually within six months, may be expected in 25 per cent of the cases in which there is injury to one or both of the recurrent nerves. Function rarely returns after that length of time.

TREATMENT

In the late twenties, Crile¹⁴ aptly remarked that unilateral abductor paralysis is unfortunate, but bilateral abductor paralysis is a tragedy. No known medical treatment will restore function, and the cause, as a rule, cannot be removed. For many years the treatment remained symptomatic or, at best, palliative.

Prior to the last decade, permanent tracheotomy with insertion of a tube or with suture of the skin to the incised edges of the trachea so as to leave a permanent opening was about the most that could be offered. As an heroic means of preventing suffocation or to relieve or prevent embarrassing dyspnea, it functioned more satisfactorily than other early methods. Nevertheless, since "no one wants to wear a piece of plumbing in his windpipe," the desire to escape the nuisance of the tracheotomy tube inspired numerous attempts through the years to devise adequate corrective measures.¹⁵ Often, however, tracheotomy is necessary regardless of what other treatment is to be given.

Baker¹⁶ pioneered in attacking the arytenoid cartilage in the surgical treatment of bilateral paralysis of the abductor muscles of the larynx. When in 1916 he removed the right cord and the right arytenoid cartilage through a laryngofissure with good results, he

was far in advance of later technics using laryngofissure as the method of approach. His work was passed over for more than two decades.

Dilatation of the glottis with bougies, admittedly of some benefit, was transient and required frequent repetition.¹⁷ It was found early that cordotomy and cordectomy, either by punch operation or by laryngotomy with excision of one cord, provided little or no relief. Jackson^{1, 18} then introduced ventriculocordectomy, which relieved the imminent danger of asphyxiation, but at the expense of the voice. It implied the removal of all of one vocal cord and the adjacent ventricular floor interior to the vocal process and for a time became the operation of choice. Many modifications of this procedure followed, but it was eventually abandoned because it sacrificed voice completely and failed to aid respiration satisfactorily in many cases.

MacKenty⁶ devised a procedure that served as an intermediate step between tracheotomy and ventriculocordectomy. Hoover,¹⁹ in 1932, reported performing submucous resection of one vocal cord with success, and four years later, Lore²⁰ suggested a more extensive submucous resection of one cord with complete removal of the arytenoid cartilage.

Cord displacement procedures included various operations designed to displace one cord in a fixed outward position. Some sought to split the thyroid cartilage and separate the anterior ends of the vocal cords by interposition of a piece of bone or cartilage, others to place the anterior end of one cord in an outward position on the thyroid cartilage, and still others to effect a fixed outward displacement of one arytenoid cartilage.¹⁵ Commenting on cordotomies, cordotomies and cord displacements, King¹⁵ observed: "One might as reasonably remove the strings from a violin and replace them with hemp rope and expect it to produce the same tone and quality of sound as to cut out a vocal cord and expect the patient so deprived to speak in a normal manner. Sufficient air may be gained, though it is of necessity gained at the expense of the voice."

Nerve anastomosis would have proved ideal had it been successful, but it was doomed to failure because of the dual function of the recurrent laryngeal nerve. Attempts were made to anastomose to the distal portion of the injured recurrent nerve the descendens noni, the proximal portion of the recurrent nerve, the phrenic nerve and the roots of the spinal accessory nerve.^{17, 21-26}

Writing in 1937, Furstenberg²⁷ observed: "The pioneers of laryngology designated the etiological factors, described the symptomatology and established principles of treatment, which for the most

part do not require revision or modification as the result of any modern discoveries of basic significance in the field. All of which again emphasizes my point of view that any effort on my part to correlate and publish our present day clinical knowledge of laryngeal paralysis would result merely in a repetition of medical history." It was indeed history that cordotomy, cordectomy and ventriculo-cordectomy had failed because of the resulting scar tissue. Anastomosis of the recurrent nerves had been a failure, not because of the surgeon's incompetence but because the impulses transmitted through the healed nerves caused spasms rather than coordination of the laryngeal muscles. Naturally, interest had lagged, for while the immediate effects not infrequently appeared to be favorable, after fibrosis occurred, one was confronted with both cicatricial and paralytic stenosis.

Two years later, King¹⁵ heralded a renaissance of interest in the correction of bilateral abductor paralysis when he introduced a constructive extralaryngeal procedure which initiated a decade of progress in surgical therapy for this distressing affliction. He paid his respects to past failures with the comment: "In the past the surgeon has sat on the sidelines and hoped and prayed a sort of sick-at-the-stomach prayer that in a few days or weeks everything would be all right. He has been delighted when in a few weeks the patient's voice began to return, only to sink to the depths of despondence when faced with the full facts of what has taken place."

THE KING PROCEDURE

It was in 1939, 23 years after Baker's report,¹⁶ that King¹⁵ first described his well known extralaryngeal operation for the relief of bilateral abductor paralysis. The idea for his new approach was based upon the procedures employed by orthopedic surgeons in dealing with motor nerve paralyses, whether of traumatic, toxic or infectious origin. Observing the success with which these surgeons transposed the tendons of functioning muscles to replace those of paralyzed muscles following poliomyelitis in the feet of children, he applied the same principle to the paralyzed vocal cord by transplanting a viable muscle to replace a functionless one.

Originally, through an incision along the anterior border of the sternomastoid muscle, he exposed the arytenoid cartilage and attached the severed anterior belly of the omohyoid muscle to the muscular process. In cases of long duration, in addition to transposition of the omohyoid muscle to the arytenoid cartilage, laryngeal reconstruction consisted of mobilizing the ankylosed cricoarytenoid joint by dividing the attachment of the interarytenoideus muscle and sever-

ing the joint capsule. Then the arytenoid cartilage was displaced outward and anchored to the thyroid cartilage until the attachment of the omohyoid muscle was firm. His best results, he later came to realize, were obtained when the arytenoid cartilage was disarticulated and fixed in the lateral displacement together with the corresponding vocal cord.⁵ "So," King himself stated, "the operation that was conceived as a method of opening the cords by the use of an extraneous muscle in actuality developed into a new method of cord displacement."

King's initial success in both widening the airway and preserving the voice offered welcome escape from the failures of the past and led many surgeons to employ this technic. Morrison,²⁸ in reporting a series of cases, declared the King operation technically and actually a successful procedure fulfilling its promises of an adequate airway and a usable voice and not limited as to age of the patient or cause or duration of the paralysis. Various modifications followed.^{12, 29, 30} Clerf,⁷ in 1950, stated that he had employed the King technic with certain modifications in all of his 66 cases. Also in 1950, Jackson¹ stated that he had adhered to the King operation in simplified form. Time eventually established that the three all important factors responsible for the success of this procedure were: (1) the disarticulation of the arytenoid cartilage; (2) the freeing of this cartilage from the tension of the interarytenoideus muscle, and (3) the fixation of this cartilage and the remaining attached tissue in abduction so that the scar tissue would maintain it in that position.¹²

THE KELLY PROCEDURE

In 1940, a year after King's initial report and while the success of the King procedure was still attributed to restoration of function to one of the vocal cords rather than to immobilization of the arytenoid and fixing it in abduction, another new approach aroused keen interest. Kelly^{31, 34} described a procedure in which he performed arytenoidectomy through a small window in the lamina of the thyroid cartilage. He attributed the good results from the King operation to the outward displacement of the arytenoid cartilage and therefore reasoned that complete removal of the cartilage would permit the cord to be more successfully fixed in a position of abduction and would also provide more space in the larynx. As originally expressed, his intention was "to get more space in the larynx by removing the arytenoid by the simplest method I could devise and to let nature relieve the patient's distress by the formation of scar tissue."³⁵ In order to insure "uniformly good results," he later found it necessary

to place a suture through the cord and to fix it away from the median line of the larynx.³³⁻³⁵

Wright³⁶ also resorted to this modification. He sutured the extreme posterior end of the vocal cord to the external perichondrium at the lower margin of the window so as to obtain a larger glottic opening posteriorly.

In order to overcome the difficulty of locating the proper position at which to make the window in the thyroid cartilage, McCall and Gardiner,³⁷ in 1943, devised a method of transilluminating the larynx by use of a brightly lighted anterior commissure laryngoscope. The shadow the arytenoid casts on the thyroid alae determines the site of the window, and once it is made by use of the laryngoscope, the arytenoid is fixed intralaryngeally with a needle or skin clip and the end of the suture is passed through the intralaryngeal mucosal membrane and out the window. Instead of being removed, the arytenoid cartilage is anchored securely in the window. Similarly, Galloway³⁸ earlier suggested mobilization of the arytenoid cartilage and its fixation to the extralaryngeal structures outside the thyroid window.

Late in 1943, Orton^{39, 40} presented another technic to simplify the arytenoidectomy. To insure a wider field for removal of the arytenoid cartilage, he preferred the lateral transthyroid approach established by Trotter,^{41, 42} with removal of the posterior portion of the ala of the thyroid cartilage to facilitate the approach to the arytenoid cartilage.

Among the various modifications of the Kelly procedure, that of Woodman^{10, 43} is particularly noteworthy. To eliminate the necessity of making a window through the thyroid cartilage or removing the posterior portion of the cartilage, he devised the open, posterior approach to external arytenoidectomy for those who prefer a wide exposure. In this procedure, following incision along the anterior border of the sternomastoid muscle, the arytenoid cartilage is exposed by disarticulating the inferior cornu of the thyroid cartilage from the cricoid cartilage; it is then sutured to the sternomastoid muscle. A suture is passed around the vocal process, care being taken to keep it in the submucosa and to pass it through and to include some of the fibers of the vocalis and the thyroarytenoid muscles. When it has been placed, all of the arytenoid cartilage except the nonarticular part associated with the vocal process is removed. This suture through the vocal muscle is then drawn laterally and tied around the inferior cornu of the thyroid cartilage, with reinforcement provided by anchoring the suture to the anterior edge of the sternocleidomastoid muscle. Incising along the posterior border of the wing of the

thyroid cartilage and disarticulating the inferior cornu offer the advantage that both of these landmarks can be identified in any neck regardless of distortion of the normal anatomy.⁴³

Barrett,⁴⁴ in his modification, employed both the principles of the Kelly procedure and the Woodman approach. He preferred an incision through the old thyroidectomy scar, like that advocated by Shirer,³⁰ giving adequate exposure for work on either side of the larynx and also better cosmetic results. The skin flap was elevated until the posterior border of the thyroid cartilage and the inferior cornu could be dissected free. Upon removal of the arytenoid cartilage, the anchoring suture in the thyroarytenoid muscle was passed through the lamina of the thyroid cartilage by means of a straight Lane cleft palate needle, bringing it through the wing of the thyroid cartilage in the same location as the window employed by Kelly. Thereby he eliminated the difficulty of working through a small opening and also preserved the wing of the thyroid cartilage to serve as an anchoring base for the vocal cord.

COMPARISON OF THE KING AND KELLY PROCEDURES

In his comparison of the two basic operations proposed by King and Kelly, Barrett⁴⁴ noted the impropriety of reference in the literature to the Kelly-King procedure.⁴⁵ While both are cord displacement operations, the procedures differ in bringing about the desired result. Each has its advantages and disadvantages, as he observed. Transposition of the omohyoid muscles is seldom carried out now that it is established that the King operation is not function-restoring. In 1937, however, King⁴⁶ remarked that he still attached this muscle to the arytenoid cartilage, but that Morrison¹² did not, and their results were equally good. The success of his procedure lies, instead, in anchoring the arytenoid cartilage in an outward position after its mobilization by division of the joint capsule and the attachment of the interarytenoid and posterior cricoarytenoid muscles. In this procedure the approach is easier; too, the mucosa of the larynx is less likely to be injured. Among its disadvantages is the tedious dissection in severing the muscle attachments and joint capsule from the arytenoid cartilage. Also, passing the splinting suture through or around the arytenoid cartilage may fracture it, with the result that the cartilage acts as a foreign body or the anchoring stitch is allowed to pull through. Another disadvantage is that the degree to which the arytenoid can be rotated laterally may be limited or at least hampered by any disproportion in the size of the arytenoid cartilage and spread of the wings of the thyroid cartilage. To Kelly's complaint of difficult bleeding in the King operation, King,⁴⁶ in 1937, replied that he had been obliged to ligate the superior thyroid artery in only

about 20 of 79 operations for bilateral cord paralysis and added that a branch of the superior laryngeal artery was prone to give trouble of a nuisance sort only.

The Kelly operation, on the other hand, relies for its success on complete removal of the arytenoid cartilage and fixation of the vocal cord in a position of abduction. One major advantage of this procedure is that removal of the arytenoid cartilage frees the paralyzed cord from all structures which fix it in the midline, thus permitting it to be sutured in a position of abduction. Another is that scar tissue contraction obliterates the space left by removal of the arytenoid cartilage and thus increases the size of the glottis. In reviewing the problems encountered in his operation, Kelly³⁴ mentioned, among others, difficulty in exposure, especially in patients with short, thick necks, and those who have had two or three thyroid operations together with roentgen therapy; troublesome hemorrhage; a freely movable arytenoid cartilage with resulting difficulty in removal and possible laceration of the laryngeal mucosa in dissecting out the cartilage; breaking of sutures on coughing or vomiting; and breakdown of cartilage in elderly patients, with subsequent delay in healing. King expressed the following view: "It is my opinion that the retention of the arytenoid cartilage is an important consideration in the operation. I think Dr. Kelly goes about his operation in the hard way. He is performing an important operation through a window in the thyroid cartilage which is $\frac{3}{8}$ inch (1 cm) in diameter." Kelly³⁵ commented: "The only argument that Dr. King and I have ever had about the treatment of this condition has been whether or not the best results are obtained by leaving the arytenoid cartilage in or taking it out. At present I believe both of us have handled a sufficient number of cases to standardize the operative procedures we have advocated, and it all depends on the surgeon's particular manual dexterity whether or not he prefers the arytenoidectomy operation or, as Dr. King says, the posterior approach."

In his discussion of the methods outlined by King and Kelly, Morrison¹² gave preference to the King operation and also emphasized in particular the difficulty most surgeons encounter in the Kelly procedure in operating through the $\frac{3}{8}$ inch square opening in the lamina of the thyroid cartilage. Both are extralaryngeal procedures designed to avoid formation of scar tissue in the interior of the larynx, but both leave two or more scars on the neck, and infection with subsequent perichondritis may occur or there may be injury to the mucosa of the larynx or pharynx. Barrett¹⁴ was of the opinion that general surgeons favor the King operation while laryngologists,

already experienced in subperichondral dissections, prefer the Kelly procedure.

Clerf⁷ directed attention to the recent report of Perello⁴⁷ in which he described a new extralaryngeal approach. His technic consists of making a window in the thyroid cartilage and suturing the superior end of the sternothyroid muscle to the internal fasciculus of the thyroarytenoideus muscle or to the true vocal cord. It is noteworthy also, in passing, that Lewy,⁴⁸ in 1941, made mention of an operation by Krainz, of Innsbruck, Austria, as follows: "His operation is done under suspension laryngoscopy and consists essentially in submucous elevation of the anterior and posterior mucosal walls of the interarytenoid region and the removal of the arytaenoideus obliquus and transversus muscles with a Patterson punch. At the 1939 meeting of the German Society of Otolaryngologists Krainz reported the cases of four patients. Each patient was wearing an intratracheal tube, which could be dispensed with after the operation. He claimed that each also had a very good voice. This he attributed to the tensor action of the cricothyroid muscle, which is supplied by the superior laryngeal nerve and is not involved in the paralysis of the recurrent nerve."

THORNELL INTRALARYNGEAL APPROACH

It was left to Thornell^{49, 50} to conceive a new intralaryngeal approach to the surgical correction of bilateral abductor paralysis of the vocal cord. In 1948 he first described an operation based upon the use of the Lynch suspension laryngoscope and consisting of complete intralaryngeal arytenoidectomy with lateral fixation of the corresponding vocal cord by electrocautery. He reported one case at that time, and in a second report⁵¹ in 1949 added two cases, in all three of which the bilateral paralysis resulted from thyroidectomy.

In these cases, after the Lynch laryngeal suspension apparatus was in position, five per cent cocaine hydrochloride was applied locally over the vocal cord and the aryepiglottic fold. During the operation a continuous supply of oxygen was administered through the tracheal cannula. After an incision 1 cm in length was made over the superior surface of the arytenoid cartilage and extended anterolaterally into the aryepiglottic fold, the superior border of the cartilage was identified and tightly held by a grasping forceps, preferably with a lock handle. Submucous dissection of the arytenoid cartilage was then carried out, with employment of a very sharp laryngeal knife to separate the various muscular attachments from the cartilage on its lateral aspect. In order to facilitate the separation of the muscular attach-

ments on the medial aspect of the cartilage, the superior portion of the arytenoid cartilage was then rotated laterally. Thornell⁵¹ emphasized the extreme importance of avoiding tearing or injuring the mucous membrane on the lateral wall of the larynx, since the attempt to increase the glottic opening may be nullified by scarring in this area with a resulting cicatrix.

When the arytenoid cartilage had been completely removed, a guarded curved electrocautery point was deeply inserted through the incision along the course of the thyroarytenoid muscle, beneath the vocal cord, and into the space previously occupied by the arytenoid cartilage. The object of this measure was to obtain further lateral fixation of the posterior two thirds of the vocal cord through contracture resulting from the electrocautery. Bleeding was minimal and readily controlled with the electrocautery unit.

In the first case a chronic surgical gut suture was employed to close the anterior half of the incision and the posterior portion was left open for drainage. In the second case the suture was omitted and an attempt was made to approximate the edges of the mucous membrane by introducing a gold-plated O'Dwyer intubation tube into the glottis. It was not anchored inferiorly, and approximately six hours after the operation the patient coughed it out. A further modification in the third case was that the O'Dwyer tube was placed between the vocal cords and anchored inferiorly to the tracheotomy tube and superiorly to the cheek.

Thornell⁵¹ concluded that an acrylic obturator, fashioned to be inserted between the cords and anchored inferiorly to the flange of the tracheal cannula and superiorly to the outer surface of the cheek with adhesive tape, produces closer approximation of the edges of the wound and speeds primary healing. It is removed in from three to seven days. For the first three or four days, laryngeal edema is pronounced, but subsides by the tenth to the fourteenth day. The cannula is removed 20 to 30 days postoperatively. He reported excellent results in establishing a normal airway in all three cases. Pre-operative and postoperative recordings of the voice indicated slight improvement in two cases, and in the third the voice was poor but adequate and showing some tendency toward improvement. His conclusion was that "this procedure is less time consuming and less shocking to the patient than the various external approaches now advocated." In September 1950, he added three cases to the three previously reported and described minor modifications in technic.⁵²

In December 1950, von Leden⁵³ reported that 22 Thornell operations had been carried out successfully and several modifications

introduced. From personal inquiry he learned that Thornell had performed the operation seven times, that Havens and his associates at the Mayo Clinic were well pleased with the operation after successfully performing intralaryngeal arytenoidectomy in 11 instances and that Edward King of Los Angeles had used the procedure twice. Von Leden⁵³ added two cases with excellent results and agreed with Thornell⁵³ that "arytenoidectomy from within the larynx has been found feasible and not particularly difficult for one trained in the use of the suspension apparatus."

He modified the Thornell procedure by the adaption of the self-retaining laryngoscope and the use of two additional very sharp dissecting instruments, a straight bistoury and an angular bistoury with double edge blades. Thereby he sought to simplify the procedure and increase its popularity, for he was convinced that laryngologists trained in the use of the suspension or self-retaining laryngoscope will prefer this intralaryngeal approach. He regarded its use particularly important in those cases in which a previous laryngeal procedure has been performed with subsequent scarring of the laryngeal structures, as occurred in one of his cases, which he believed to be the only case on record in which a successful intralaryngeal arytenoidectomy followed on the same side an unsuccessful extralaryngeal operation.

In April 1951, Brown⁵⁴ reported three cases of intralaryngeal arytenoidectomy, with good results in two, in which he modified the Thornell operation. After removing the arytenoid cartilage and accomplishing hemostasis by means of the electrocoagulation current, he placed a mattress suture of 00 chromic catgut so that it entered the lateral aspect of the aryepiglottic fold, passed through the posterior end of the vocal cord, and then passed back through the aryepiglottic fold close to its point of entry. The purpose of this suture was to pull the cord laterally, not to close the incision, which was not sutured. He omitted insertion of an intubation tube, as employed by Thornell.⁴⁹⁻⁵² Also, he suggested that if the patient's upper front teeth are precarious, an acrylic mold to fit over the front teeth be made previously. It is made long enough exteriorly to permit it to rest against the anterior nasal spine, to which pressure of the Lynch suspension apparatus is transferred. On insertion of the suspension apparatus, it should be remembered, he pointed out, that only the posterior part of the larynx is to be exposed. Since this exposure may be accomplished without elevating the epiglottis, edema of this cartilage, which seems to delay subsidence of the operative edema of the arytenoid region, may be avoided.

In evaluating this intralaryngeal approach, this author mentioned as advantages: simplicity, since the operation is less formidable and less time-consuming than the extralaryngeal approach and since the arytenoid cartilage is so much more easily located; reduction of the possibility of wound infection; less likelihood of the postoperative formation of hematoma which may cause a reduction in the calculated width of the glottis; and immediate and constant view of the amount of space that is being provided between the vocal cords. He observed only two disadvantages: rarely, possible technical difficulties encountered in the use of the Lynch suspension apparatus; and the question of whether or not the vocal cord can be displaced far enough laterally without suturing it to the wing of the thyroid cartilage.

Emphasizing the importance of considering many factors in the treatment of bilateral abductor paralysis of the larynx, notably the size and shape of the larynx, the sex of the patient and his psychology, Brown⁵⁴ concluded: "The result that could be called a success for the person who does sedentary work might be called a failure for the laborer. The result that could be called a success for the person who does not have to use his voice except to make his wants known might be a failure in a clergyman or a teacher. If time should prove that similar results can be obtained by the extralaryngeal and the intralaryngeal approaches, the latter will surely have one thing in its favor: ease and simplicity of procedure."

Recently, Brown⁵⁵ stated that he had now used the modified Thornell operation in seven cases with satisfactory results. He had had one case in which the operation could not be completed because of excessive hemorrhage, the wound being packed with gelfoam. He was of the opinion that the Thornell procedure has opened a new approach to an old problem and is deserving of a thorough trial.

Lynch,⁵⁶ in a personal conversation of recent date, related that his group had performed intralaryngeal arytenoidectomy in 12 cases. They have found this procedure successful in patients who do not have to be particularly active physically. Their conclusion was that this procedure is better suited to patients over middle age who lead sedentary lives than to younger more active patients, for whom they prefer the extralaryngeal approach because in their opinion it gives the better airway.

In late August 1951 Thornell⁵⁷ in personal communications stated that he knew of approximately 70 cases in which the intralaryngeal approach had been employed, a number of which had not yet been reported. Geographically, they were distributed as follows:

Rochester, Minn., 35; Chicago, 15; Cincinnati, 9; Atlanta, 7; and Los Angeles, 3. Thornell^{57, 58} added that he now makes the incision over the superior surface of the arytenoid cartilage "approximately 1 to 2 mm medial to the cartilages of Santorini and Wrisberg so as to avoid these cartilages in the dissection." This modification, he believes, speeds the operation slightly. In one of his nine cases "it was necessary to do an arytenoidectomy in the same manner on the opposite side because the airway was not quite large enough. This case turned out very satisfactorily and the patient has an excellent voice."⁵⁷

To the rapidly growing number of cases in which intralaryngeal arytenoidectomy has been performed since Thornell⁴⁰ introduced his procedure in 1948, I desire to add two cases in which I used the Thornell operation with the Brown modification and obtained excellent results.

REPORT OF CASES

CASE 1.—Mrs. A. L., a white woman aged 52, was referred by a local surgeon on Jan. 9, 1951. In 1945 in Hawaii she had undergone thyroidectomy. Tracheotomy was necessary at the time of the thyroidectomy since both recurrent laryngeal nerves had been severed. Since that time she had been wearing a tracheotomy tube and was so severely handicapped that she was unemployable and miserable.

Examination by mirror showed both vocal cords fixed in the midline. When the tracheotomy tube was covered, there developed stridor and respiratory difficulty of considerable degree. The voice was very poor, and the patient was depressed mentally because of her condition.

On May 10, 1951, intralaryngeal arytenoidectomy was performed according to the Thornell technic as modified by Brown. Intravenous pentothal sodium with curare was used for general anesthesia. The Lynch laryngeal suspension apparatus was introduced, a previously prepared acrylic stent being used to protect the teeth and jaw, and the patient was placed in position. The left aryepiglottic fold was then injected with a one per cent solution of novocain. Incision was made over the length of this fold with a laryngeal knife, and the arytenoid cartilage was seized with a mouse-tooth laryngeal forceps. By means of laryngeal scissors the arytenoid was freed and delivered. There was minimal bleeding, which was controlled by electrocautery. A single suture was placed loosely in the gaping mucous membrane. No intubation tube was put in place.

The postoperative course was uneventful. Laryngeal edema lasted for more than a week, subsiding rather quickly. On June 18, the patient was decannulized. The left vocal cord had deviated posteriorly, giving her an adequate airway and a considerably better voice. When she was seen on June 26, she had recovered from her depression. She was talking much better and no longer experienced stridor. She could walk up and down stairs without difficulty and was seeking employment.

CASE 2.—Mrs. R. A., a white woman aged 49, was first examined by me on Nov. 11, 1950. Four years previously a local surgeon had performed a thyroidectomy, and immediately thereafter severe respiratory difficulty and great stridor had developed. She was unable to perform any useful task and could not go up

and down stairs. She had to sleep propped up on pillows, and her respirations at night were so loud that it was difficult for the family to sleep. Her condition was one of semi-invalidism, but she had not been tracheotomized.

On May 17, 1951, tracheotomy was performed under local anesthesia. Immediately afterward, the patient was anesthetized by intravenous pentothal sodium with curare and a Lynch suspension apparatus was put in place. A previously prepared acrylic stent was used to protect the teeth and jaw. The right arytenoid area was injected with a one per cent solution of novocain, and incision was made over the right arytenoid cartilage. This cartilage was then seized with a mouse-tooth forceps and delivered through the incision by means of sharp dissection and the mouse-tooth laryngeal forceps. The little bleeding which occurred was controlled by electrocautery, and no intubation tube was inserted. The wound was closed with one single loose stitch.

Postoperatively, laryngeal edema persisted less than two weeks and subsided rather quickly, as in Case 1. On June 13, the patient was decannulized. At that time, examination disclosed that the right vocal cord had been displaced laterally sufficiently to provide an adequate airway, and she was far more comfortable. When seen on August 10, she reported she was walking up and down stairs and pursuing her normal household activities. The inspiratory crow during sleep no longer occurred, and she was generally greatly improved.

COMMENT

It is desirable, prior to performing intralaryngeal arytenoidectomy for the first time, for one to dissect an arytenoid cartilage from a freshly laryngectomized patient. The intralaryngeal procedure is not difficult compared with any external approach. Placing the suture in the mucosa can be somewhat tedious; I find that a light long aneurysm needle is best.

I have had no experience with a self-retaining laryngoscope, but when the Lynch suspension apparatus is used, the protective acrylic stent for the teeth and jaw is a necessity in my opinion. This precautionary measure was taken in both of my cases.

In my cases excellent anesthesia and relaxation were obtained by employing a combination of pentothal sodium and curare, supplemented by intratracheal oxygen.

It appears that missionary work remains to be done among thyroid surgeons for the prevention of injury to the recurrent laryngeal nerves during thyroidectomy. Lahey and Hoover²⁶ reported the incidence of such injury as varying from 1½ to 3 per cent of cases and regarded it as a largely avoidable catastrophe.

The measures to guard against this accident have long been stressed in the literature: (1) Careful examination of the larynx before thyroid surgery;^{28, 50} and (2) routine dissection and demonstration of the recurrent laryngeal nerves at the time of surgery.²⁶ Several authors⁵⁹⁻⁶¹ noted that in approximately one per cent of pa-

tients examined in routine preoperative procedure for conditions not related to the thyroid gland, unilateral paralysis of the vocal cord is present. It would, therefore, seem most inexpedient to perform thyroidectomy in any case without full knowledge before operation of the condition of the vocal cords.

SUMMARY AND CONCLUSIONS

The incidence, etiology and symptoms of bilateral laryngeal paralysis are briefly presented.

The evolution of the surgical therapy of this distressing condition, which most frequently is a complication of thyroidectomy, is traced in some detail. Reviewed in particular is the progress of the last decade, in which the introduction of the King and, later, the Kelly extralaryngeal procedures brought about a renaissance of interest in the treatment of this paralysis.

The Thornell intralaryngeal approach is described. The procedure has stimulated the interest already generated by the methods of treating bilateral abductor paralysis advocated earlier by King^{5, 15} and Kelly,³¹⁻³⁵ and others who proposed various modifications of these procedures, notably Woodman^{10, 43} and Barrett.⁴⁴ The modifications of the Thornell intralaryngeal arytenoidectomy advocated by von Leden⁵³ and Brown⁵⁴ are also discussed.

Two cases of bilateral laryngeal paralysis following thyroidectomy are reported in which the Thornell procedure as modified by Brown⁵⁴ was successfully carried out.

Which method will eventually emerge as the procedure of choice remains problematic. The intralaryngeal approach recommends itself by its simplicity. As yet, however, it is not possible to have the best airway with the best voice. I prefer, at present, that my patients do not talk too well. It may be, as Brown⁵⁴ intimated, that patients will be selected on an anatomic basis. For those with a large larynx the intralaryngeal procedure may prove most suitable, and for those with a small larynx the extralaryngeal procedure may be preferable.

Every effort should be made to reduce the incidence of bilateral laryngeal paralysis as a sequela of thyroidectomy by observing the precautions mentioned, which have long been urged in the literature.

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XVI

AURAL MANIFESTATIONS OF ALLERGY

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The one time revolutionary allergic approach to the management of many previously considered surgical problems in rhinology is an accepted fact in our specialty. Now, a similar plan of allergic therapy aimed not only at treating symptoms, but also at the fundamental cause of several acute and chronic disorders of the external, middle and internal ear is evolving.

Allergic disease is most often found in such tissues as the skin and the mucous membranes of the respiratory and gastro-intestinal tracts since they are the principal contacts of the human organism with the substances of the environment. The embryological derivatives of those tissues are similarly but less frequently affected by the allergic reaction. The salivary glands, the pancreas and the nasal accessory sinuses are examples. The middle ear and eustachian tube lined by respiratory mucosa, and the membranous labyrinth in the internal ear derived from an infolding of the fetal ectoderm, are pertinent examples.

Although the concept that allergic diseases do occur in the ear is not new, the general acceptance and recognition by the otologist of the frequency of allergic states in the ear is not as yet an accomplished fact. Several reasons exist for the failure to recognize allergic ear disease, as well as other allergic disorders. The most important reason is the lack of one accepted conclusive test to prove allergy. The finding of increased eosinophiles in secretions or tissues is strong presumptive evidence of an allergic reaction, but it is not conclusive evidence. Skin tests as a diagnostic measure can often be misleading and disappointing. The most reliable proof of an allergic etiology is the therapeutic test, but even this is not completely conclusive due to the tendency to spontaneous remissions in allergic conditions, particularly in acute ones. The long standing chronic diseases which are resistant to all other forms of treatment and which respond to allergic management should be considered as allergic in origin.

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What percentage of our otologic cases respond to allergic investigation and treatment, I am not prepared to say. However, I can say with certainty that as these measures are applied more frequently in our therapy-resistant cases, the percentage seems to increase correspondingly. At present, our plea is to add the allergic approach to the armamentarium of the otologist, with the confident expectation that the results will be rewarding.

Aural manifestations of allergy fall into the usual three divisions: the external, middle and internal ear.

ALLERGY OF THE EXTERNAL EAR

Eczema of the external auditory canal and of the auricle is frequently a troublesome experience in therapy. After examination and treatment for a possible fungus or other infection, elimination of such contacts as drugs or cosmetics, and x-ray therapy we are still left with a number of therapeutic failures. In spite of the opinion of certain dermatologists and general allergists that there are no proven cases of specific food or inhalant allergy responsible for dermatitis of the ear, judging by the therapeutic test this approach to treatment has been employed to our satisfaction. An illustrative example is the following case:

CASE 1.—Mrs. E. L. aged 60, complained in January, 1949, of a bilateral hearing impairment which had been progressive for the past 44 years, and which was diagnosed as bilateral clinical otosclerosis. For many years the patient was troubled by an alternating crusty and weeping dermatitis of the left external auditory canal and postauricular region. At one time the skin lesion had extended over the ear, around the eyes, mouth, chin, neck and chest. Previous varied local treatment had been in the hands of a dermatologist. In spite of intradermal skin tests which did not signify an allergic factor, an attempt to prove such a factor was continued. A somewhat desultory trial on housedust injections yielded no results. The "basic elimination" diet approach resulted in establishing pork as the primary offender, and avoidance of pork resulted in complete clearing of the eczema. Subsequent recurrences could be traced to pie and cake, both prepared with lard (pork), and frankfurters which contain pork were another established offender in one instance.

External otitis without the complicating eczematoid involvement of the auricle is a very common otologic condition. The majority of cases are due to specific infection by organisms such as staphylococcus aureus, bacillus pyocyaneus, the atmospheric molds such as aspergilli, and the pathogenic molds—the dermatophytoses, all of which generally respond to thorough cleansing and appropriate local medication. However, in a considerable number of cases in which these local measures fail, specific allergic management provides the solution. Diagnosis of a specific inhalant or food factor poses the usual difficulties, in contrast to the relatively simple diagnosis of acquired drug sensitivity.

A typical therapy-resistant type of external otitis is encountered in the management of persistent discharges following fenestration and mastoid surgery, and in these cases specific allergies to an inhalant, a pollen or a food as well as to drugs used locally have been found. These cavities may or may not be completely epithelialized. In either case the secretion can be exactly the same; the usual description in our office records is a foul-smelling tan muco-pus. We have been able to demonstrate as high as a 4 plus eosinophilia (according to Hansel) in smears of this viscous secretion in many but not all of these cases. The following cases are typical of a small percentage of fenestration cavities which fail to become healed and dry, or which after initial complete healing begin to drain, and finally are cleared by specific allergic therapy.

CASE 2.—Mrs. L. W. aged 39, had a fenestration operation in August, 1946 which restored and maintained her hearing well above practical level. The cavity healed uneventfully and was observed to be perfectly dry and completely epithelialized seven months after surgery. A few months later a persistent foul purulent secretion began to drain from the cavity and continued in spite of repeated cleansing and various local medications including sulfonamides and antibiotics. A recurring dermatitis of the hands during the wintertime, and a positive skin test to housedust extract suggested a dust allergy. A single injection of Hansel's housedust extract, 0.1 cc of 1-10 million dilution, resulted in immediate complete cessation of the aural discharge. Several wintertime recurrences of the discharge have ceased on the same dosage with definite improvement in the dermatitis of the hands.

CASE 3.—Mrs. D. A. aged 24, had a fenestration operation in October, 1948 with restoration and maintenance of hearing above the practical level. Healing of the cavity proceeded uneventfully until two months postoperatively when a weepy discharge with excoriation of the concha developed and continued profusely for 18 months despite every possible local medication, and a thorough trial of housedust desensitization. Search for food sensitivity was undertaken by placing the patient on a "basic" diet, which resulted in increased aural discharge and the onset of eczema of the face, chest and axillae. Careful study of the dietary records kept by this patient traced the flare-up to eating tuna fish canned in cottonseed oil. After omitting cottonseed oil from the diet the ear became dry, with several subsequent transient discharges traced to inadvertent cottonseed oil ingestion. Tuna fish without cottonseed oil contamination did not produce any discharge.

ALLERGY OF THE MIDDLE EAR

Chronic suppurative otitis media of the benign type with an odorless mucoid secretion coming from a large central perforation is very often due to a specific allergy. The encyclopedic work of Koch,¹ inspired by his teacher Dohleman, on investigations of chronic allergic otitis published in 1947 is certainly a great stride forward in the development of our knowledge of aural allergy and should be required reading for every otologist. Dohleman,^{2,3} through his demonstration of eosinophiles in the secretions from the middle ear and by allergic examination of individual cases, was one of the first

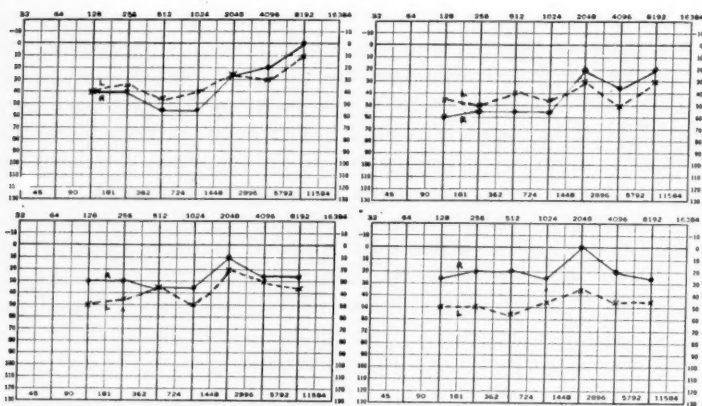


Fig. 1, Case 4.—(upper left) 11-6-50—Original test with both ears draining. (lower left) 11-6-50—Test with paper patch prosthesis in the right ear and a korogel insert in the left ear. (upper right) 12-19-50—Both ears dry after allergic treatment. (lower right) 11-24-51—Hearing improvement after treatment closing perforation right drum membrane.

to draw attention to the important role of allergic factors in the etiology of protracted and therapy-resistant cases of chronic otitis. A summary of Koch's investigations of 222 patients with 262 cases of manifest chronic otitis helps to establish the clinical picture of eosinophilic or allergic chronic otitis, and speaks very strongly in favor of an allergic etiology of the eosinophilic chronic otitis. Of the 262 cases of manifest chronic otitis, 52 cases (19.8%) had a secretion eosinophilia and suggestive proof of an allergic etiology.

The comparative development of the clinical picture of eosinophile cases reveals a fairly well-defined type of chronic otitis with the following characteristics: (1) A secretion, in most cases, having a remarkably viscous or gelatinous consistency with a considerable but varying number of eosinophiles; (2) a middle ear mucous membrane which is fairly thickened and often similar in appearance to the nasal mucosa in allergic rhinitis with numerous eosinophiles; (3) a protracted time of healing; (4) occurrence in individuals of allergic disposition manifesting other allergic symptoms, most commonly allergic rhinitis; and (5) likely response to anti-allergic treatment.

CASE 4.—Mr. V. P. aged 34, complained of bilateral chronic aural discharge with impaired hearing for 18 years. Both tympanic membranes showed large central perforations with a mucoid odorless secretion containing a moderate amount of eosinophiles on several examinations. For years many previous treatments, including every type of antibiotic used systemically and locally, had failed to dry

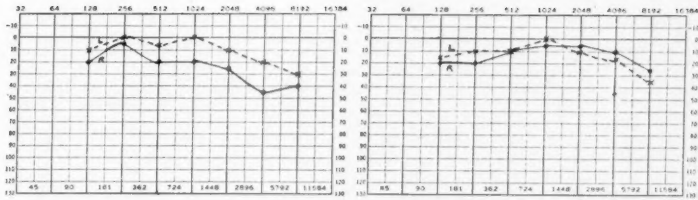


Fig. 2, Case 6.—(L) 10-2-50—Original audiogram with secretory otitis right ear. (R) 11-20-50—Maintained hearing improvement after housedust desensitization.

up the discharge for more than a few weeks at a time. A wintertime complaint of nasal blocking and postnasal discharge due to a perennial allergic rhinitis was a better lead to the presence of an inhalant, housedust sensitivity than selected intradermal skin tests showing a borderline positive reaction to housedust. Routine cleaning of the ears and varying housedust extract dilutions finally arriving at a weekly maintenance level of 0.2 cc of 1-1 million resulted in both ears remaining dry, permitting treatment to close the perforation in the right ear with restoration of hearing to the practical level (Fig. 1).

CASE 5.—Miss S. W. aged 48, had had large dry central perforations in both tympanic membranes for many years. In November, 1950 both ears began to drain a profuse mucoid secretion. Many eosinophiles (3 plus) in the aural secretion directed our attention to a probable allergic etiology. On questioning we found that the ears had begun to drain immediately after she began to use a feather comforter on her bed. Despite an almost negative skin test to feathers, the ears became dry as soon as the comforter was discarded and the pillows covered.

Secretory otitis media, with occlusion of the eustachian tube, the accumulation of a clear yellowish serum in the middle ear and a conductive hearing loss, may be due to mechanical obstruction of the tube by adenoids, carcinoma, sudden increase in atmospheric pressure (aero-otitis), or a simple head cold. However, we find that the majority of cases of chronic secretory otitis with either a clear serum or a much thicker mucous are due to a definite allergy to housedust or to a food, and until the allergy is recognized and controlled the middle ear continues to fill with fluid despite repeated paracenteses, inflations, adenoidectomies and radium or x-ray treatments to the nasopharynx.

The extent of mucosal involvement by the allergic reaction varies from that of the nose, nasopharynx and tubal orifice to the inclusion of the entire mucous membrane of the eustachian tube and the tympanic cavity with its mastoid extensions. When the allergic edema is confined to the mucosa of the nose, nasopharynx and the region of the tubal orifice, enough mechanical obstruction can result

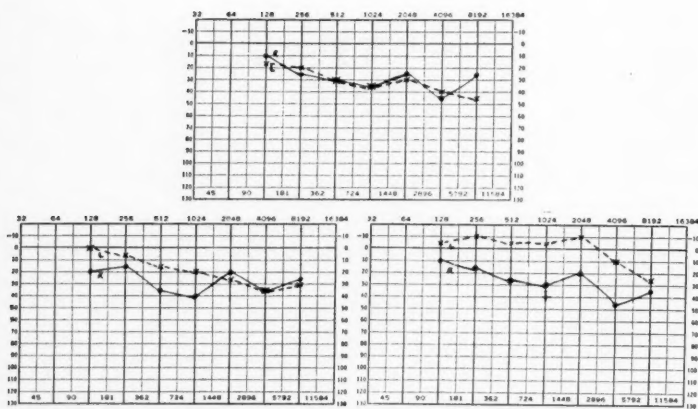


Fig. 3, Case 7.—(Top) 5-21-47—Original audiogram with bilateral hemotympanum. (lower left) 11-29-47—Hearing gain left ear following first successful inflation. (lower right) 12-4-48—Maintained hearing improvement left ear and no change right ear after allergic management.

to cause an accumulation of clear serum in the middle ear in a manner similar to that produced by adenoids and carcinoma. Carrying our theorizing a bit further; the allergic reaction in tubal and tympanic mucosa is more likely to produce the thicker mucous secretion containing eosinophiles comparable to that of allergic chronic otitis in comparison to the usually non-eosinophilic thin serum resulting from less extensive respiratory membrane involvement. This point needs further study and clarification.

Jordan⁴ in 1949 reported 123 cases of chronic secretory otitis media with 91 cases (74%) due to allergy. The diagnosis of allergy was made by nasal smears, skin testing and response to allergic therapy in 88 of the 91 cases. The lack of permanent relief for chronic secretory otitis from removal of adenoids and radium irradiation to the nasopharynx in the allergic case was emphasized by Jordan, also.

Hoople,⁵ in his paper on otitis media with effusion, read before the Academy of Ophthalmology and Otolaryngology in October, 1949, mentions in his discussion of etiology that the goodly number of allergic patients affected by secretory otitis media suggests that "conditions outside the ear may be factors for the presence or continuation of fluid in the ears," and that "it is this area that we, as otolaryngologists, may have an Achilles heel." However, Hoople does not emphasize the role of allergy as does Jordan.

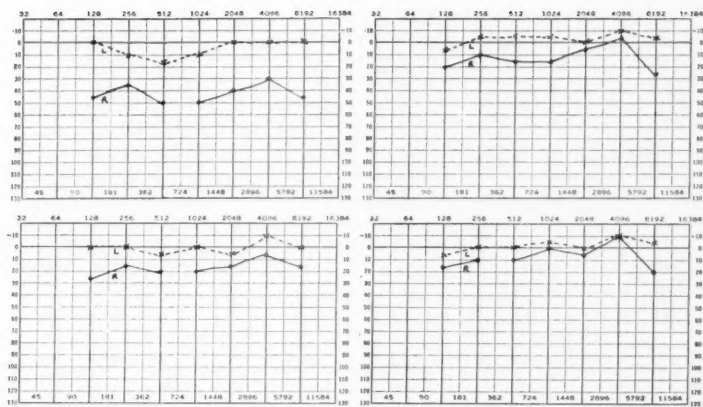


Fig. 4, Case 8.—(upper left) 5-15-50—Original audiogram with hemotympanum right ear. (lower left) 5-20-50—Improvement after skin tests alone. (upper right) 6-16-50—Ten days after adenoidectomy. (lower right) 8-5-50—After control of nasal allergy.

CASE 6.—Mr. M. van M. aged 50, complained of impaired hearing in the right ear for three months, a chronic stuffy nose and postnasal discharge. Repeated inflations and paracenteses performed elsewhere, as well as three paracenteses performed in our office, evacuated clear yellow fluid containing a few eosinophiles (1 plus), but the relief was transitory. Housedust extract injections of 0.05 cc 1-10 million dilution with another paracentesis resulted in complete clearing of the middle ear and restoration of normal hearing (Fig. 2), with moderate improvement in the chronic nasal symptoms.

Chronic hemotympanum is a special, rather rare form of secretory otitis media which we have found to be usually allergic in origin.

CASE 7.—Mr. E. M. Jr. aged 19, in May, 1947 complained of impaired hearing for eight years, with a cough and headcold that lasted all winter long. Both tympanic membranes were deep blue, with a bilateral hearing impairment. Adenoidectomy, radium to the nasopharynx and inflations were of no avail. Dilute dust therapy with maintenance varying from 1-100 million to 1-1 billion dilution resulted in clearing of the left ear and restoration of normal hearing (Fig. 3) with disappearance of the winter cough and nasal symptoms. Four years later, the left ear has remained clear, but all efforts to open the right eustachian tube have failed.

CASE 8.—J. M., a nine year old girl, complained of a hearing impairment in the right ear for nine months, with persistent nasal blocking which was worse during the winter, since infancy. The right tympanic membrane was completely blue, with a moderate conductive hearing loss. The nasal mucosa as well as an adenoid remnant completely filling the nasopharynx showed a typical pallid, boggy appearance. Repeated local treatments to the nose for "sinusitis" and a course of three x-ray treatments to the nasopharynx prior to consulting me had produced no change. Selected intradermal skin tests yielded a borderline positive reaction to housedust, a poor indicator of a considerable housedust sensitivity. However,

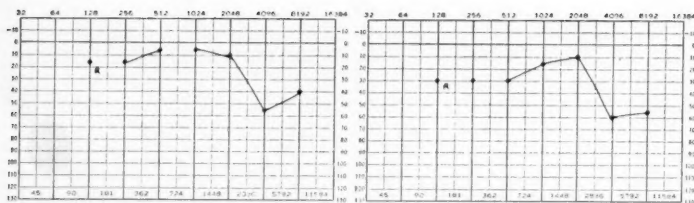


Fig. 5, Case 9.—(L) 12-11-50—Original audiogram with "low-tone" perceptive deafness right ear. (R) 3-13-51—Improvement following maintenance housedust desensitization.

these skin tests alone with no inflations resulted in immediate (first day after tests) improvement in nasal stuffiness and hearing (Fig. 4) and examination five days later revealed the right middle ear to be less than one-half filled with dark blue secretion.

Very little further improvement in hearing was gained after a thorough adenoidectomy, and to restore normal hearing it required complete control of the nasal symptoms by two injections of Hansel's housedust extract, 0.10 cc 1-100 million dilution (Fig. 4). Dust therapy was discontinued after two months of complete control, and examination one year later revealed minimal symptoms with normal hearing in the right ear.

ALLERGY OF THE INNER EAR

Labyrinthine hydrops with a low frequency fluctuating hearing impairment of the perceptive type, often with diplacusis, fullness and attacks of vertigo, is a fairly frequent cause for impaired hearing. The fact that specific sensitivity to various foods and inhalants can exist in the inner ear is not new, for numerous writers including Duke, Rowe, Proetz, Vogel, Malone, Vaughan and others reported cases as early as 20 to 30 years ago. While in most cases of hydrops we are unable to demonstrate an allergic etiology, in some there is a very definite response to specific management.

CASE 9.—Mr. J. S. aged 44, complained in November, 1950 of tinnitus and impaired hearing in the right ear for one month, with slight persistent dizziness. The left ear had been totally deaf since a head injury in childhood. Air and bone audiometry, together with a positive 256 Rinne, demonstrated a mild "low-tone" perceptive deafness, in the right ear (Fig. 5). Searching for an allergic cause, we placed him on a "basic" elimination diet without effect. Following selected skin tests for dust, feathers and cigarette smoke, all resulting in moderate positives, he was definitely improved. With this lead, a trial on housedust therapy resulted in arrival at 0.1 cc of a 1-100 billion dilution as a maintenance dosage resulting in disappearance of the dizziness and tinnitus, and a clearing of the low-tone hearing loss, leaving only a high frequency notch from previous acoustic trauma (Fig. 5). The patient was allowed to discontinue his maintenance dust therapy during the summer of 1951 and was entirely symptom-free until October, 1951. Then a recurrence of dizziness, tinnitus and impaired hearing cleared immediately following resumption of previous housedust maintenance.

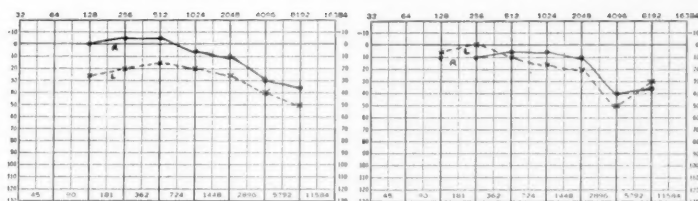


Fig. 6, Case 10.—(L) 12-11-47—Original audiogram with mild perceptive deafness left ear. (R) 6-29-48—Maintained improvement after tobacco and garlic avoidance.

CASE 10.—Mr. W. G. aged 42, complained in December, 1947 of a severe attack of vertigo with a mild hearing loss in the left ear lasting one year. Audiometry and tuning fork examination revealed a mild low-tone perceptive deafness in the left ear. History rather than equivocal skin tests led to omission of tobacco and garlic (of which he had consumed large amounts for 15 years) and resulted in a prompt maintained restoration of hearing except for a mild pre-existent high-tone defect present in both ears (Fig. 6).

SUMMARY

Our experience has been that therapy-resistant chronic cases of external otitis, of suppurative otitis media of the benign type and of secretory otitis media are frequently allergic in origin and respond to specific allergic management. In contrast, unfortunately, only a small number of cases of labyrinthine hydrops can definitely be proven allergic to a specific inhalant or food. However, the excellent results in proven allergic cases of hydrops treated with specific allergic therapy justify consideration of a possible allergic etiology in all cases.

The examination of aural secretions for eosinophiles is as valuable a diagnostic measure in chronic allergic ear diseases as it is in nasal allergy.

As in nasal allergy, a thorough history is more rewarding in the detection of a specific allergic factor in aural allergy than are the skin tests.

The final proof of an allergic etiology and of a specific allergen depends upon the therapeutic test—if removal of a specific substance or treatment with an extract of this substance relieves the symptoms, and if the symptoms recur on reexposure or after the treatment has been discontinued, we may assume that the particular substance is responsible for the symptoms.

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XVII

DOES THE UTRICULAR OTOLITHIC MEMBRANE MOVE ON POSTURAL CHANGES OF THE HEAD?

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This question proved troublesome to settle because technical difficulties as a rule would prevent any accurate measuring on living or newly killed animals. The problem is of decisive importance, however, to our conception of the mechanism of the labyrinthine function.

Among previous investigations into this matter, mention is to be made of a paper by Ruysch (1909), who attempted to photograph the position of the otolith membrane in the elasmobranchial labyrinth in various postures of the head. He found no definite movements of the otolith membrane.

Among more recent investigations, particular mention is to be made of a work published by de Vries (1950), who gives an account of similar roentgenograms of the ruff (*acerina cornua*), perch and pike, showing that the saccular otolith shifts on movements of the head. These shifts correspond to, or are somewhat larger than, those which will be mentioned for the utricular otolith in *acanthias*.

For technical reasons it has not been practicable previously in any animal to demonstrate any shifting of the utricular otolith in relation to the underlying structure in various postures of the head.

Without being acquainted with the above investigations, in the summer of 1947 and again in autumn, 1949, the writers took a good many x-ray pictures of the otolith masses in *acanthias*, the selection of which is cartilaginous, in order to ascertain whether postural changes of the head of the animal would bring about any changes in the position of the otoliths in the labyrinth.

In collaboration with H. C. Rask-Nielsen and P. Stoeckel, at the Roentgenological Department, Central Hospital, Hjoerring.

As mentioned already, the otoliths produce sharp and distinct shadows on x-ray films. So it seemed reasonable to think that if postural changes of the head made them move in the labyrinth, these movements might be measurable on the pictures.

The principal difficulty was implied by the circumstance that the roentgenograms had to be taken within a couple of minutes after the death of the animal, because the consistency of the gelatinous substance then changes rapidly, becoming more viscous. This observation had been made previously by the writers in studies on the saccular gelatinous substance in sharks as well as cod.

MATERIAL AND TECHNIQUE

Altogether 15 sharks were roentgenographed for this purpose, seven in 1948, the rest in 1949. The films taken in 1948 had to be left out of consideration because the writers had failed to demarcate precisely such labyrinthine landmarks as might be utilized for the subsequent measurements (i.e., no metal wire had been introduced in the medial wall of the skull—see below).

Some very obliging fishermen brought the sharks alive to the harbor of the Skaw; all were in good condition. The sharks were then placed in a sufficiently large tank, on an auto-truck, and transported, on good level roads, to the Central Hospital in Hjoerring. Here the sharks were taken out of the water, one at a time, and carried to the X-ray Clinic where they were decapitated and prepared for roentgenography. This was concluded before the decapitated body had ceased wriggling. In every instance the photography was completed in less than five minutes after the decapitation of the animal. The time was taken, and it averaged three and a half minutes for the first photo, five minutes for the last one.

The preparation of the specimen proceeded as follows: After decapitation, the skull was divided in the midline. The skin over the labyrinthine region was pulled off, entirely or partially, and the floor of the oral and pharyngeal cavity was removed with strong poultry shears. A fine metal wire, threaded on a needle, was inserted through the snout and pulled out through the occipital region in a way giving the thread a long free course along the medial wall of the cranium, a little dorsally to the level of the recessus utriculi.

Then the specimen was placed in the x-ray apparatus on a hexangular plate of bakelite, provided with two claps to hold the specimen firmly (Fig. 1).

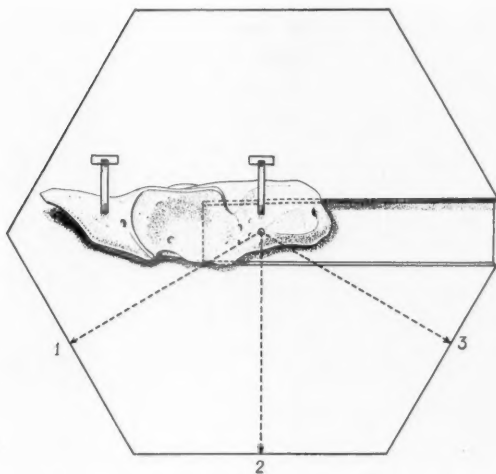


Fig. 1.—Mounting of the cranium for roentgenography, from the side. The cranium, one-half, is fixed to the plate by two clamps. The groove is seen in which the dental film could slide in behind the specimen. For "chin-down" photos, the plate was standing on the edge marked 1, for normal posture on the edge marked 2; and for "chin up" photos, on the edge marked 3.

A shallow groove was made in the upper surface of the plate corresponding to the size of the films employed (Gevaert's extremely fine grained films of odontological film size). By means of this groove, a film could be pushed in under the specimen, exposed to the x-rays, and exchanged with another film without the specimen being displaced in relation to the bakelite plate.

One-half of a skull was placed on the plate and fixed by means of the clamps; a film was pushed in under it and exposed to the x-rays. Then the bakelite plate was turned around one of its corners, so that it now was standing at a new edge, and another film was exposed in the new position.

The direction of the rays (with maximal closure of the diaphragm) was horizontal, and the bakelite plate was placed so that it rested on one of its edges, leaning against the plate of the cranial table. In all the exposures the utricular otolith was situated at the place of the central ray. Every time the bakelite plate was turned over a corner, the specimen was rotated 60° around a transversal axis through the utricular recess.

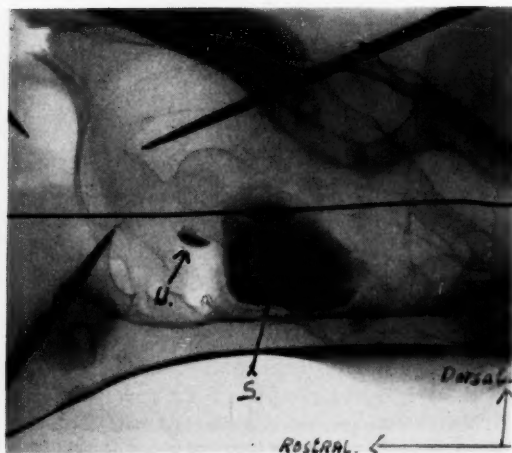


Fig. 2.—X-ray photo of the labyrinth of *acanthias*, taken from the side, showing the sharply defined shadow of the utricular otolith (arrow). Posteriorly to this, the finely streaked shadow of the saccular otolith is seen as well as the vaguely defined shadow of the lagena-otolith. The outlines of the perilymphatic spaces of the semicircular canals are seen. Also seen are a piece of metal wire and three pins inserted in the specimen.

The first film was taken in "chin down" posture, the second in an almost normal posture of the head, and the third with the chin up. All pictures were side-views (Fig. 2).

A total of 16 half-skulls were roentgenophotographed. The quality of the pictures varied a little, and only eight of the series met the very strict requirements necessary for the measurement.

The actual measuring of the pictures took place in the Institute of Neurophysiology, where Dr. Knappeis obligingly helped the writers in working out a suitable measuring technique.

It would take too much space to go through the variegated difficulties associated with this measuring. Here it will suffice to state that the "chin-down" and "chin up" pictures in every series were measured, with the normal posture pictures employed for control. The measurements were obtained by measuring the angle between a line through the upper margin of the otolith membrane and the metal wire in the specimen. In all the specimens the first line, which in the following is designated as the "otolith-line," ran rostro-dorsally; the second line, the "wire line," was almost horizontal. An angular dif-

ference between the lines in the chin-up picture and the chin-down picture would mean that the otolith membrane was rotated in relation to the cranium, and this would again mean that it was rotated in relation to the macula, which has to follow the movements of the cranium. The measuring itself was carried out by means of a microscope with a metal centering circular stage graduated along the margin to 360° and equipped with a nonius which allowed readings with an accuracy of 0.1° . On this circular stage was fitted an attachable mechanical stage. The measuring was performed by means of a screw micrometer eyepiece with movable crossline. The roentgenograms were fastened to the mechanical stage by means of tape, and then the stage was rotated so that the otolith-line ran parallel with one of the threads of the cross in the eyepiece. After this, the mechanical stage was rotated again until the same thread in the eyepiece paralleled with the wire-line in the picture. Both of the degrees here involved were read.

The difference between the two degrees gives the angle between the otolith-line and the wire-line in the picture concerned.

On the average, a microscope enlargement of 15 times was employed and thus the granules of the film played no particular role in the measurements.

Each series of three pictures was measured several times (with 20 measures in each). The measuring was performed by two examiners and several measuring series were controlled in this way; one examiner rotated the stage; the other read the degrees.

RESULTS

All the measurements showed some difference in the size of the angle measured, and a wider angle was always found in the chin-down posture. Calculated as the average, this difference was $2.0^\circ \pm 0.08^\circ$.

This means that the otolith membrane does not quite follow the rotation of the recess (cranium) but is lagging, i.e. trying to remain in the same place when the cranium rotates. Its movement can have taken place only as a "sliding movement" in the sub-otolithic clear zone, the zone between the dark otolith mass and the border of the sensory cells, as the measurements show that the gelatinous, otolith-containing substance itself must have moved in relation to the sensory cells. It proved impracticable to ascertain any shifting of the otolith by measuring its distance, for instance, from some fixed points in the perilymphatic spaces, even though these

clearly can be made out in the pictures. The method here described afforded the only chance of carrying through the measuring successfully. On account of the granules in the film, the distance, for instance, between the most anterior point in the saccular otolith and the hindmost point in the utricular otolith could not be measured with an accuracy of such a small fraction of a millimeter that any positive difference might be expected.

ANTEROPOSTERIOR EXPOSURES

It seemed desirable to supplement the above lateral views with exposures able to show whether similar otolith movements might be demonstrated in the frontal (transversal) plane.

Technically, such pictures were far more difficult to take because in rostro-caudal photography of entire specimens the otolithic mass of the sacculus will be projected into the shadow of the utricular otolith. After many futile attempts the following procedure was adopted: After decapitation of the animal, the cranium was divided by two vertical sections. One section passed along the border between the orbits and the labyrinthine regions, the other down through the two sacculi. The contents of the sacculi were removed by means of a cotton swab, and the slice containing both utricular recesses was then photographed in two views, namely: "right side down" and "left side down." The specimen was standing in vertical position and rotated round its center.

Here the measurements proved far more difficult than in the lateral exposures, among other reasons because the medial outline of the utricular otolith coincided with a sharply drawn contour of the cartilage of the cranium. The procedure, therefore, was limited to bring forth the "otolith-line" on both sides and see whether the two otolith-lines crossed in the mid-line or to one side of it. The latter proved to be the case, and when the lines crossed, for instance, on the right side in one position of the specimen, they would be crossing on the left side in the other position. When the specimen was photographed in the normal posture, the two lines crossed in the midline or very near it. As to the extent of the otolith movements, nothing definite could be said. Altogether five young sharks were photographed in this way and gave concordant results of the measurings.

On the basis of these x-ray findings it may be taken for granted that the "otolith-membrane" in vivo is able to move in toto in relation to the sensory epithelium of the utricular recess. The movements are very small though still measurable. This is in contrast to

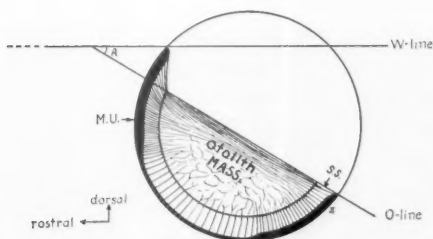


Fig. 3.—Schematic drawing showing the utricular recess (drawn as a circle), the utricular otolith, the sensory epithelium of the macula (black) and the sub-otolithic zone with the thready suspensory apparatus and the fibrillar extensions from the sensory cells. O.: otolith-line; W.: wire line; S.S.: subotolithic space; M.U.: macula utriculi.

the movement of the cupulae ampullares described in a previous paper by one of the authors. An unexpected confirmation of this experimental conclusion was obtained in another series of x-ray examinations performed for another purpose.

An untreated preparation was photographed in side view with employment of the technique mentioned before. After this, an aqueous contrast medium was injected into the anterior vertical semi-circular canal. Because the injection was performed a little too rapidly the specimen may have been exposed to slight traumatic injury. The following roentgenogram (Fig. 4) showed that the utricular otolith was rotated so that the "otolith line" now pointed forward and downward instead of forward and upward as in the first and all other pictures. For that matter, the outline and density of the otolith mass looked quite "normal" in the picture; no visible injury to the otolith-containing gelatinous substance itself could be made out. Undoubtedly, the suspensory apparatus or the sub-otolithic zone must have been the subject of some injury, but obviously such a thing could happen without the contours of the otolithic gelatinous mass becoming uneven or notched.

The cleavage of the tissue must have taken place in the zone most loose in texture. This zone proved to be the sub-otolithic zone, within which we must expect to find so much "looseness" that a shift may occur here under normal physiological conditions.

Correlation of Histological Knowledge and Roentgenographic Findings. The pictures showed indisputably that any movement of the otolithic membrane had to take place in the sub-otolithic zone (described by Werner a.o. 1940). Any motional deflection due to



Fig. 4.—X-ray photo of the labyrinth of acanthias. The ant. semi-circular canal (to the left) is injected with a contrast medium, and an air-bubble is seen in the anterior ampulla. The picture shows that the utricular otolith, which otherwise always is facing obliquely upwards and posteriorly, here is facing obliquely upwards and anteriorly on account of traumatic injury from the injection. As a matter of fact, it really looks whole and apparently undamaged. U.: utricular otolith; S.: saccular otolith.

a shift in this zone, which is shown in Fig. 3, will be limited by the structure and physical character of the zone. No matter whether the contents of the zone consist in parallel threads uniting the sensory cells with the fibrillary stroma of the otolithic membrane, or whether they form a network uniting the epithelium to the stroma of the covering substance, the length and possible elasticity of the threads will be decisive of the maximal deflection.

For the sake of simplification of this problem, let us say that the contents of this zone consist of parallel threads (Fig. 3), the central end of which is immovably fixed at its site of departure from the sensory cell, while the peripheral end extends into the thready stroma of the otolith mass. Movements of this mass take place through parallel shifting of the lower, convex surface of the otolith in relation to the sensory epithelium. Thus the threads become deflected so that their peripheral insertion will follow the movement of the otolithic mass while the central end remains fixed. Taking into consideration the depth of the zone (measured by the authors to 70-120 μ , it will be reasonable to assume that under physiological conditions their peripheral points of insertion will not be displaced more than 15 μ , at the most, in either direction, i.e. about 30 μ altogether.

With our present knowledge of the size and form of the otolithic membrane here dealt with, it can be reckoned that such a shift (of $30\ \mu$) will correspond to a change of 1 to 2° in the angle between the "otolith-line" and the "wire-line."

This change in the angle corresponds to the one that can be measured on the roentgenograms by comparison of the sizes of the angle in the two extreme positions of the otolith. It was to be expected that the roentgenography would show the maximal deflections and these have indeed served as the basis for the calculation above.

Thus, the present studies have lent support to the idea that a shift in the effect of gravitation upon the otolithic membrane brings about a deflection of the projecting parts of the sensory cells (the "threads" or the "cilia"). This deformation may reasonably be assumed to constitute the immediate cause of the changes in the sensory epithelium decisive of transmission of nervous impulses.

SUMMARY

The gelatinous substance is movably located on the macula utriculi. On movements of the head of the piked dogfish the gelatinous substance has a tendency to remain in situ. Thus, for instance, if the head is rotated 90° round the binaural axis, the utricular otolithic mass is seen to rotate merely $88-89^\circ$. On the average, the maximal movement of the utricular otolithic membrane as measured on the x-ray pictures amounts to $2^\circ \pm 0.08$.

A corresponding tendency to remanence is seen on postural changes taking place by rotation round the longitudinal axis of the animal.

UPLANDSGADE 36 B.

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XVIII

NASOPHARYNGEAL RADIUM TREATMENT

A FOLLOW-UP STUDY OF 263 PATIENTS

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AND

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Radium treatment of the nasopharynx for a variety of conditions due to benign, hyperplastic, but infected lymphoid tissue has found wide approval and application, but has not remained unopposed. It has been inferred that radium treatment of the nasopharynx as devised by Dr. Crowe and the late radiologist, Dr. Curtis F. Burnam, might produce detrimental effects on both the doctor and the patient, but so far as we know no proven case of damage has ever been reported. With the introduction of atomic energy the dangers of irradiation have received much publicity. Several reports on the ill effects of irradiation, particularly accidental and total body irradiation, have been published and discussed. It is obvious that our problem is quite different, since the radium is applied to a localized field in a well defined and well controlled dosage. From the very beginning, the originators of this treatment have been aware of the dangers and have repeatedly warned against improper or careless usage. Although we have used this type of therapy for 25 years at the Johns Hopkins Hospital and have seen no ill effects from radium treatment of the nasopharynx for benign lymphatic hyperplasia, a follow-up study of our treated patients is indicated to determine this important point more definitely. The primary aim of this investigation is to present the objective findings and late clinical results of nasopharyngeal radium therapy and to see whether or not any tissue changes, attributable to irradiation, occur such as telangiectasis, chronic infection or crust formation. Another aim is to present the functional results of the treatment and the appearance of any lymphoid tissue that may remain in or around the pharyngeal orifice of the eustachian tubes or in the fossa of Rosenmuller.

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All patients who had received radium treatments five or more years ago were contacted by letter and asked to return. If it was not possible for the patient to return for examination he was requested to fill out an enclosed questionnaire inquiring about the original symptoms, the result of the treatment and his impression of the value of the treatment in his case or in that of his child. Six patients who had been treated less than five years ago heard about this investigation from their physician or a friend and returned without being asked. Approximately 700 questionnaires were sent out. One hundred and seventy-nine letters were returned undelivered. Several patients had died from causes not related to irradiation or to the condition for which irradiation was given. Eighty-six patients returned for the examination and 177 filled out the questionnaire. Several more failed to answer the questionnaire, but promised to return for examination in the near future. A surprisingly large number of patients traveled a great distance at their own expense, for this examination. All patients included in this study had had irradiation of the nasopharynx alone. All who had had surgical removal of the tonsils and adenoids at or near the time of the radium application were excluded, as were those whose symptoms depicted in their original history were in disagreement with the answers in the questionnaire.

All patients re-examined in this study had been originally seen, carefully examined and treated with radium by Dr. Crowe or his associates. The earlier patients had been treated with a radon applicator screened with gold 1 mm in thickness. Some years later we changed to 1 mm of chromium plated brass, still later 1 mm of aluminum, and for the past ten years the 0.3 mm stainless steel radium applicator was used. All patients who returned for re-examination and evaluation were examined by the authors. A complete ear, nose and throat inspection was made, including the use of the nasopharyngoscope. All tuning fork, voice and audiometric studies were made in a sound-treated room. Eighty-six patients were thus re-examined. Only one objected to the nasopharyngoscopic examination. Of the remaining 85 patients, five showed some enlarged blood vessels in the nasopharynx but no "spiderwebformation." Blood vessels similar in appearance are often seen with the nasopharyngoscope in patients who have never had contact with radium or even diagnostic x-rays, and one would be hesitant to ascribe the presence of these blood vessels to irradiation. Two patients had slight crusting in the nasopharynx; one was a heavy smoker and stated spontaneously that the crusting disappears when he stops smoking. The second patient had subacute ethmoiditis and pharyn-

gitis, and remarked that crusting occurs for a time after each head cold. No evidence of ulceration or tumor formation was seen in any of the 85 patients. In all patients the pharyngeal orifice of both eustachian tubes was clearly visible and of normal configuration. No sign of atrophy or abnormal patency was seen in any patient. In the majority (56) of the patients a small amount of lymphoid tissue remained, and in two it had recurred to a greater degree. In every patient the lymphoid tissue that remained had lost the irregular, ragged appearance of enlarged or infected adenoids. Neither the time that had elapsed since the treatment, the number of treatments, nor the age and sex of the patient had any apparent influence on the findings.

In evaluating the functional results, we must remember that the indication for irradiation had to be established empirically, and that many of the symptoms mentioned in the tables were not the primary reason for advising this type of therapy. From approximately 1924 to 1934 radium treatments were employed only to restore or prevent further hearing loss due to the overgrowth of lymphoid tissue in or around the pharyngeal orifice of the eustachian tubes. Observation of other beneficial effects led in the course of the years to recognition of other indications for this method of treatment. In the analysis of functional results the material was subdivided into two groups: 1) patients who had been re-examined in the course of this investigation and 2) patients who had answered the questionnaire. The average time that had elapsed since the last radium treatment for the re-examined group was 8.9 years and for the other group 9.3 years. In one patient in the re-examined group the last radium treatment was 15 years, in one 21 years and one 29 years previous to this study. The results in groups 1 and 2 are essentially the same and will therefore be discussed together. None of the 263 patients could remember any immediate untoward symptoms following their irradiation treatments, but we know from experience that some patients do have a feeling of fullness and irritation in the nasopharynx and at times also in the ears for 24 to 48 hours. Some also have an excessive nasal and postnasal mucous discharge for the same length of time. Irradiation is always an irritant and always causes some edema of the mucosa. It was by observing these reactions with a nasopharyngoscope after each treatment and for weeks after the completion of the series of three treatments, and noting when they subsided, that the present dosage (12 minutes with the 50 mg 0.3 mm monel metal radium applicator) and the interval between treatments (two weeks) was established. The patients who showed improvement of hearing acuity, almost without exception,

had a conductive type of hearing impairment. Those with an acquired or congenital perception deafness, or otosclerosis (including adhesive middle ear processes) either remained stationary or became worse in the course of the years. Our object in irradiating this latter group was to try to prevent additional impairment due to blockage of the eustachian tubes or suppurative otitis media with each cold.

The favorable results of radium treatment on recurrent otitis media are unquestionable. Prior to the use of radium in the nasopharynx for this condition most of the patients in this group had received treatments of many different types, including repeated surgical removal of the adenoids without permanent results. Antibiotics will cure acute otitis media, but if the primary cause (hyperplastic lymphoid tissue in or around the pharyngeal orifice of the tubes) is ignored, the ear symptoms are likely to recur with the next cold, and repeated infections may lead to irreversible middle ear changes and permanent impairment of the hearing. Significant improvement was also noted in patients, especially children, who had frequent head colds, excessive coughing and asthma. It would be well to point out that in most of these patients frequent upper respiratory infections, cough and asthma were complained of at the time of their original examination, but were not the primary indication for irradiation of the nasopharynx. It was only when these patients returned several weeks or months after their last irradiation treatment and volunteered the information that their colds were less frequent and less severe, that they coughed less and had no asthma, that we began to realize the important role of the nasopharynx in the production of these symptoms. The results of radium treatment in this study in respect to these symptoms are therefore not necessarily representative of the total group. It is obvious that radium treatment is not a cure-all and that the results of treatment depends on careful evaluation and correlation of the history and physical findings and clinical judgement.

CONCLUSIONS

1. No late detrimental effects of irradiation or any other visible tissue pattern that could be explained as due to the application of radium have been found in any of the 85 patients who have been re-examined from three to 29 years after radium treatment of the nasopharynx.

2. The presence of a small amount of lymphoid tissue in the nasopharynx in about two thirds, of the patients examined in this

study indicates that the dosage recommended by Dr. Burnam and used for 25 years by Dr. Crowe and his associates fulfills the requirement: not to destroy or remove all lymphoid tissue, but to use irradiation as you do antibiotics or surgical removal of adenoids for the relief of symptoms, in selected cases.

3. The eustachian tubes were not overgrown with lymphoid tissue in any of the patients, which indicates that the radium treatments retarded the growth of adenoid tissue effectively in this location.

4. The late results of radium treatments are very encouraging. As one would expect, the best results were obtained in patients whose symptoms were due to infected lymphoid tissue and mechanical interference with the function of the eustachian tubes.

5. Hearing was usually improved following these treatments provided the impairment was not due to otosclerosis or a chronic adhesive middle ear process that interfered with the movement of the ossicular chain. We do irradiate the nasopharynx in selected cases with known otosclerosis or with a perceptive type of hearing impairment. The object of treatments in this group of patients is not to restore the basic hearing defect, but no help protect what hearing the patient has and to prevent further loss from colds, acute and chronic nasopharyngitis and interference with the function of the eustachian tubes. In such cases the combined use of an antibiotic to cure the infection and irradiation to remove, or change the contour or flatten out the crypts to prevent reinfection, is more satisfactory than either of these measures used alone.

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TABLE 1.—ANATOMICAL FINDINGS OF THE NASOPHARYNX IN
RELATION TO TIME SINCE RADIUM TREATMENT.

Time in Years Since Treatment	Number of Patients	Average Number of Treatments	Vascular Changes	Dryness	Tumor	Ulcer	Adenoids				Eustachian Tubes		
							None	Small	Moderate	Large	Clear	Part.	Compl.
3-4 (3.3) Average	6*	3.2					4		1		5		
5-9 (7.6) Average	49	2.6	1	1 Infection			7	41	1		49		
10-14 (11.0) Average	27	2.9	4	1 Smoking			14	13			27		
15-29 (21.7) Average	3	3.0					1	2			3		

*One patient did not submit to the nasopharyngoscopic examination.

TABLE 2.—ANATOMICAL FINDINGS OF THE NASOPHARYNX
IN RELATION TO NUMBER OF RADIUM TREATMENTS.

Number of Treatments	Time since Treatment in Years	Number of Patients	Vascular Changes	Dryness	Tumor	Ulcer	Adenoids				Eustachian Tubes		
							None	Small	Moderate	Large	Clear	Part.	Compl.
1	6-13 (8.8) Average	12		1 Infection			5	7			12		
2	3-12 (8) Average	23*					4	16	2		22		
3	3-29 (9.7) Average	33	4				15	18			33		
4	6-13 (8.6) Average	8		1 Smoking			2	6			8		
5	8-10 (9.2) Average	5					3	2			5		
6	4-12 (8.75) Average	4	1				2	2			4		

*One patient did not submit to the nasopharyngoscopic examination.

TABLE 3.—ESTIMATED RESULTS OF NASOPHARYNGEAL IRRADIATION ON HEARING IMPAIRMENT.

IMPAIRED HEARING				
ESTIMATED RESULTS	CONDUCTIVE	OTOSCLEROSIS	PERCEPTIVE	MIXED
Improved 100%	25		1	
75%	9		1	1
50%			1	
25%	2			
Unchanged		20	31	
Worse		3	1	1

TABLE 4.—ESTIMATED RESULTS OF NASOPHARYNGEAL IRRADIATION ON SYMPTOMS PRESENT AT THE ORIGINAL EXAMINATION.

ESTIMATED RESULTS								
SYMPTOMS	100%	75%	50%	25%	2%	0%	50% to 100%	0% to 25%
Otitis Media	31	21	2	4		2	54	6
Tinnitus		1				1	1	1
Sore throats	11	7	6	1		2	24	3
Headache	29	24	8	4	2	11	61	17
Sinusitis	5	3	4	1		3	12	4
Postnasal Discharge	2	3	1	1		3	6	4
Cough	14	6		1		2	20	3
Asthma	3	4	1			1	8	1
Sneezing		1	2				3	

XIX

STUDIES WITH STEAM GENERATED AEROSOLS

THE CLINICAL APPLICATION OF ANTISPASMODICS,
MUCOLYTICS, ANTIBIOTICS AND OTHER AGENTS
IN A VARIETY OF SINO-RESPIRATORY DISEASES

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The therapeutic application of aerosols in medical practice is now an established fact. The first international symposium on this subject attests to this, and the voluminous literature of the past few years adds further confirmation.

There are a number of basic questions to be answered. Is there any particular advantage to the application of a given drug by the aerosol method as compared with its introduction into the body by other means? If that is so, how shall that aerosol be administered—in solid or aqueous form? What are the advantages and limitations of each of these? Shall aerosols be limited to therapy directed specifically at the sino-respiratory apparatus, or can we utilize the lungs as a portal for the introduction of medication for systemic effect? What are the factors that determine absorption through the lung barrier? Can we utilize aerosols for diagnostic purposes? Several possibilities suggest themselves, including that of outlining the bronchial tree by the inhalation of radiopaque aerosols. These questions, along with such technical considerations as the choice of an aerosolizer, the vehicle for conveyance of the aerosol, and the selection of the particular size of a given aerosol, are particularly germane for consideration at this symposium on aerosol therapy. Collectively, we may answer some of these basic questions and collectively, we will find other questions in the wake of those answered. Such is the way of science.

The present communication is primarily a review of the author's experience with steam-generated aerosols. It is hoped that this will

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answer in part some of the questions raised. It would be of interest to this international audience to review briefly the development of aerosol therapy in the United States. It serves as an essential background for the writer's own studies.

HISTORICAL

Asthma, because of its particular nature, has always been a fruitful field for experimenting with therapeutic aerosols. Smokes of stramonium have long been in use. When epinephrine was introduced by Abel and Crawford¹ and shown by Bullowa and Kaplan² to be effective in asthma, attempts were subsequently made to treat this disease by inhalation of epinephrine 1-1000, with little success. With the introduction of an improved hand-bulb nebulizer, and by the employment of a ten-fold (1-100) concentration of this drug, Graesser and Rowe in 1935 successfully treated asthma with this aerosol.³ Subsequently, Richards, Barach and Cromwell (1940) developed a means of continuous aerosol production, utilizing oxygen under pressure as the conveyor, and applied epinephrine 1-100 and neosynephrine to the treatment of asthma and emphysema.⁴ At this time Abramson (1940) made fundamental observations on factors controlling the stability of aerosols.⁵ With the advent of the sulfonamides clinical reports by Stacey (1943)⁶ and by Applebaum (1944)⁷ appeared, describing the application of aerosol of sodium sulfathiazole in the treatment of respiratory infections. Chapple and Lynch (1944) applied micronized (solid) aerosol of sulfathiazole experimentally and clinically, and observed a therapeutic blood level of the drug for many hours following inhalation. The possibility of the lung acting as a depot was suggested.⁸

The introduction of penicillin accelerated research in aerosol therapy. Bryson, Sansome and Laskin (1944) reported the successful production of aerosols of penicillin and its absorption by the experimental animal.⁹ Prigal and Speer (1945), utilizing a steam generator, described the production of aerosols of penicillin, sulfadiazine, aminophylline and other medications, and of the attainment of high blood levels of penicillin following inhalation of its aerosol.¹⁰

The first clinical report on penicillin aerosol in the treatment of respiratory infections was that of Barach et al (1945).¹¹ Olsen (1946) utilized streptomycin in the treatment of bronchiectasis.¹² Prigal and Furman (1949) described the clinical use of bacitracin as an aerosol in sino-respiratory infections,¹³ and terramycin in propylene glycol was applied clinically by Prigal (1951).¹⁴

Other contributions in the field of aerosol therapy came from the clinics of Barach on the treatment of sinusitis, advocating intermittent suction,¹⁵ and Segal and his co-workers who applied penicillin in a variety of respiratory infections,¹⁶ experimented with various bronchodilators¹⁷ and studied absorption through the lung.¹⁸ Bryson and Grace reported clinical experience with penicillin aerosol, and advocated zephiran chloride as a vehicle, the detergent qualities of the latter enhancing penetration of the antibiotic.¹⁹ Abramson suggested hydrogen peroxide as an aerosol for respiratory infection.²⁰ Finke simplified aerosol therapy at home by the use of a bicycle pump, and advocated prolonged therapy with penicillin for bronchiectasis,²¹ subsequently reporting several cures.²² Prigal et al advocated the use of propylene glycol as a vehicle for the antibiotics, and devised methods of confining and conserving the aerosol for maximum utilization. A tent and chamber (bathroom) method of treatment for infants and children, as well as for the simultaneous treatment of several members of the family was described.²³ The prophylactic application of penicillin aerosol in sino-respiratory infections was advocated by this clinic,²⁴ along with the application of bacteriologic methods in the choice of the antibiotic to be administered as an aerosol.^{14, 43} In view of the prolonged blood levels attained with penicillin aerosol, using a steam generator, propylene glycol as the vehicle, and the breathing box or tent for maximum utilization of the aerosol,²³ Prigal suggested the possibility of employing aerosols for the introduction of medications for systemic action.²⁵ The use of aminophylline as a bronchodilator for asthma, and ammonium chloride as a mucolytic agent for bronchitis and bronchiectasis, was also reported by the same investigators.²⁶

As for the development of solid aerosols, Chapple and Lynch (1944) had introduced micronized sulfathiazole powder in the treatment of respiratory infections, but this was abandoned because of the irritation produced by this drug.⁸ Subsequently, Taplin and Bryan (1947),²⁷ and Krasno, Karp and Rhoads (1947)²⁸ advocated the use of micronized penicillin powder as an aerosol. Powders of norisodrine sulfate (isuprel),²⁹ theophylline³⁰ and streptomycin³¹ have likewise been introduced. The simplicity of administration of this method and its general availability for self-therapy has won for it many adherents. There are, however, disadvantages such as irritations, allergic reactions, drying of bronchial secretions, and obnoxious tastes of the various powders employed which will have to be overcome. It is evident that both solid and liquid aerosols have their specific fields of usefulness, and these remain to be delineated.

STEAM GENERATED AEROSOLS

Since 1944 the author has produced aerosols by means of steam. The steam generator and aerosolizer, converted from a disseminator of insecticides as described in 1945¹⁰ has certain advantages. It is simple, compact, readily transportable, and one could employ it with equal facility in the hospital, office and home. Self-administration is feasible. In addition, it could aerosolize large volumes of a variety of liquids and oils within a short period of time. With the use of a regulating device the onset and the rate of flow could be regulated. It was noted, however, that with the employment of aqueous solutions the particle size was relatively large. With the use of a baffle, recently developed, or by employment of the breathing box described below, an excellent aerosol is obtainable in the magnitude of $2-3\mu$.³² With a movable baffle the aerosol size may be varied as desired, an accomplishment not possible with the commercial nebulizers, and duplicated only by Rooth's complex nebulizer.³³

The apparatus is based on a relatively simple principle. Electrodes are suspended in a cylindrical container holding water. With the application of current, steam is generated under pressure, and when passing through a small aperture and over a venturi tube picks up and aerosolizes the medicament into which the tube is immersed. Safety features include a pressure safety valve and automatic cutting of the current when the water falls below the level of the electrodes.³⁴

Steam power is one of the most efficient means of producing aerosols and, in addition to its own therapeutic value, enhances the aerosol by greater tolerance on the part of most patients. Because of its warmth it causes greater absorption from the respiratory tract, which accounts for the high blood levels of penicillin obtained with this apparatus. Barach,³⁵ and Beakey, Gaenster and Segal,³⁶ by warming their aerosol of penicillin generated by oxygen and a glass nebulizer, demonstrated increased absorption as reflected in the blood levels. Castex and Capdehourat,³⁷ and Rooth³³ employ electric bulbs along the pathway of the aerosol for the purpose of warming it, since too cold an aerosol may produce coughing or substernal pain. A similar device was demonstrated to the author in Paris by Dr. B. Halpern in Prof. Valery-Radot's Clinic.

Having sought and found an apparatus suitable for producing aerosols rapidly from large volumes of solutions, consideration was given to the choice of a proper vehicle for aerosolization. It is notorious that aqueous solutions when converted into a fine aerosol evaporate very rapidly. The life of a droplet of the magnitude of 2μ in dry air at room temperature is only .006 seconds.³³ The finer

the aerosol the more rapid the vaporization, due to the increase in surface. This aerosol is said to be unstable. It is possible, however, with the addition of a number of factors to stabilize this aerosol. Thus, it can be shown that the addition of glycerol or certain salts and sugars may produce a more effective aerosol by reducing the vapor pressure.⁵ Experiments with a variety of liquids led to the selection of propylene glycol as the most suitable vehicle for the production of long-lasting aerosols. It is an excellent solvent for many substances insoluble in water, is miscible with aqueous solutions in all proportions, is odorless and has a pleasant sweet taste. It is non-toxic even when inhaled over long periods of time. Propylene glycol can destroy penicillin on prolonged contact; freshly prepared solutions should, therefore, be employed.³⁸ Furthermore, with the addition of small amounts of glycerol to the propylene glycol solution, the aerosol can be stabilized further.

In sequence, it was then necessary to find ways and means of conserving and confining the aerosol for maximum utilization, since it was apparent that the aerosol was produced more rapidly than it could be utilized. This led to the utilization of such devices as a tent, a small chamber in which the patient was confined (ultimately the bathroom became the chamber best suited for this purpose at home), and finally the breathing box was developed into which the aerosol was blown and from which the patient inhaled by means of tubes and valves. The box was a cube of 12 inches; through an aperture in the rear of the box the aerosol was introduced. Inhalation was effected from the front by means of a mask and tube. Valves were so placed that the patient could not exhale into the breathing box. Thus, there was eliminated the hazard of CO² retention. The breathing box, tubes and valves all aid in baffling the aerosol so that when inhaled it has the properties of a fine smoke.²³ Since condensation occurs within the box the condensate may be collected and can be reaerosolized if desired, as it is still quite potent.³⁹

In addition, the patient could sit in front of the aerosolizer and breathe the aerosol as produced. This was the simplest of the methods but less efficient than the breathing box or tent, as determined by penicillin blood level studies following inhalation of its aerosol.

The bathroom method of treatment is given special consideration later in the discussion of treatment of infants and children.

MATERIALS AEROSOLIZED FOR EXPERIMENTAL OR THERAPEUTIC PURPOSES

With the use of the steam aerosolizer it has been possible to employ a variety of aerosols, singly or in combination. These may readily

be classified into mucolytics such as ammonium chloride and the steam itself; spasmolytics (bronchodilators) such as epinephrine, neosynephrine, aminophylline, norisodrine (isuprel, aleudrine); antibacterial and antibiotic agents such as sodium sulfadiazine, sodium sulfacetamide, penicillin, streptomycin, terramycin and bacitracin; hormones such as insulin and cortisone tricapryllate; a fungicide such as sodium capryllate; an antihistamine; benadryl, and miscellaneous items such as propylene glycol and a variety of oils. In the attempt at bronchography with aerosols, radiopaque substances such as potassium iodide (solution and powder) and iodized oil were used.

ANTISPASMODIC (BRONCHODILATOR) AEROSOLS

To the sufferer of asthma who can relieve his attack almost instantaneously with one or several inhalations of epinephrine 1-100, there is no question as to the advantage of this therapeutic method to that of hypodermic injection. The prompt use of an aerosol of a suitable bronchodilator at the beginning of an attack of asthma, may abort it completely. Then again, aside from the convenience of self-administration it is possible to avoid the obnoxious side reactions of tremor, pallor and apprehension commonly seen following an injection of epinephrine 1-1000. Although a stronger solution (1-100) is used by inhalation, it is concentrated primarily at the desired site of reaction, the pulmonary tree, thereby avoiding generalized reactions. Excessive use of aerosols of the bronchodilators may, in the uninitiated, produce alarming side reactions⁴⁰ or become completely ineffective from continued use and development of "fastness." Possibly the latter phenomenon is related to the antagonistic action of adrenalin and histamine as suggested by Yonkman et al.⁴¹

Aminophylline. The antispasmodic agent with which the author has had most experience is aminophylline. This has proved to be of great value in controlling bronchospasm, which is one of the dominant factors in asthma but which is also present in chronic bronchitis, bronchiectasis, emphysema, and in other pulmonary diseases. There are obvious advantages to the use of aminophylline in aerosol form. It is simple to inhale, is readily self-administered, and is devoid of the untoward reactions encountered with intravenous administrations.²⁶ Likewise, one eliminates the gastro-intestinal complaints following oral ingestion of this drug. It does not have the disadvantages of so many of the other spasmolytic agents such as epinephrine or isuprel, which induce apprehension, elevate the blood pressure or increase the pulse rate. Segal et al have reported aminophylline, either in the form of powder or liquid aerosols, to be a poor bronchodilator.⁴² Taplin et al, using powdered aerosols of aminophylline or theophyl-

line reported, however, favorable results in asthma.³⁰ Segal's failure with liquid aerosols may possibly be due to the limitations of the nebulizer he employs. With the Vaponephrine or DeVilbiss No. 40 nebulizers in which the solution must be concentrated, it is not uncommon to blow off the water, leaving a residue of aminophylline. With the employment of compressed air instead of oxygen, further difficulty is encountered since the CO₂ of the air precipitates the aminophylline.

Reported observations by Prigal, Brooks and Harris²⁶ on 40 patients treated with aminophylline revealed that 32 or 80% were afforded some degree of relief. Five patients suffering from severe asthma responded to aminophylline by inhalation after failing to respond to it intravenously. There were, however, cases unresponsive to the aerosol that did respond to the intravenous injection. Vital capacity studies were undertaken in nine patients, before and after inhalation of aminophylline aerosol, and there was an average increase of 20% in the vital capacity following such an inhalation (.25 Gm in 10 cc water). A control series with another set of nine patients in which aminophylline was given intravenously in one-half the dose inhaled (.125 Gm in 5 cc H₂O) resulted only in a 12% improvement as compared to 20% by inhalation.

It is difficult to explain why the aerosol resulted in greater improvement than the intravenous injection. Possibly this was due to greater concentration of the drug where its action is most desired.

Isuprel (Aleudrine, Norisodrine). The next most frequently used spasmolytic agent has been isuprel. This has been used singly but more often in combination with the aminophylline. There are advantages to the use of such a combination, since it reduces the total amount of isuprel needed to control an asthmatic attack. This is important in view of the intolerance of some patients to this drug, manifested by complaints of weakness, apprehension, tachycardia or precordial distress.

Epinephrine. Epinephrine aerosol administered by means of the steam aerosolizer has had limited study, since this has been readily administered by the ordinary hand bulb nebulizer and has already received considerable attention. There is no reason, however, why this sympathomimetic drug, used singly or in combination with other bronchodilators, should not be as effective when administered in this fashion.

The method and dosage of the bronchodilators as employed by the writer is given in the appended table.

ANTI-BACTERIAL AND ANTIBIOTIC AEROSOLS

Aside from ease of administration (except for those medications administered orally) of an aerosol of the antibiotics, there is the particular advantage of concentrating these agents where they are needed most. It has been recognized that following systemic administration of the antibiotics and antibacterial agents, there is very little or no secretion of these into the respiratory tract. Estimation of penicillin in the sputum of patients, following large doses by injection, have shown only traces in the bronchial secretions.³³ It is possible, however, by direct application into the lung, either by instillation or by inhalation, to achieve high concentrations of the antibiotics otherwise unattainable by injection. Possibly direct installation is more effective and economical since there is no loss of the antibiotic as occurs in inhalation. It is, however, a laborious procedure and an uncomfortable one for the patient, and in no way compares with ease of administration of an aerosol, nor can it be self-administered, which is readily possible with an aerosol.

An additional advantage of the use of the aerosol method is illustrated with bacitracin, in which a relatively toxic agent can be employed with safety by inhalation for topical action, since it is not ordinarily absorbed from the lung.¹³ In the case of penicillin and streptomycin one observes a two-fold action: the advantageous local action with high concentration at the site of deposition followed by systemic action of the antibiotic when absorbed. Indeed, such high blood levels of the antibiotics (penicillin and streptomycin) may be attained as to suggest the pulmonary route as a possible means of administration for systemic action^{20, 39} This is demonstrated later in the discussion of the treatment of sub-acute bacterial endocarditis.

Indications for Aerosol Therapy with Specific Antibiotics. The presence of infection is the sole criterion for therapy with aerosols of the antibiotics. In the case of infective asthma the history is often revealing. Many of the patients treated related the onset of asthma to an acute respiratory infection such as tonsillitis, sinusitis, bronchitis, pneumonia, measles or pertussia. Where the origin was obscured by time, there was a history of asthma only or primarily in the "cold" seasons, with definite aggravation following an acute upper respiratory infection. Indeed, a good number could account for asthma only on the basis of infection, there being no history of any specific sensitivities to foods or inhalants. Those with long standing and perennial asthma frequently recall that during the first years asthma occurred only during the winter, and later became

perennial. Another group with known sensitivity to pollens could relate an aggravation and prolongation of their symptoms (asthma or hay fever) beyond the seasons, due apparently to infections superimposed upon the allergy, of which the patient was not usually aware. Those who suffer from respiratory symptoms due to allergens other than pollen may follow a similar course, infection complicating the allergy and at times replacing it as the etiological factor in the production of symptoms.

In addition to the revealing history, the next most useful criterion from a clinical point of view was the presence of infection as evidenced by an inflamed mucous membrane associated with purulent secretion in the nose (from frank pus to adherent crusty, dry, purulent mucous) or in the nasal pharynx. At times the evidence of infection was noted in purulent expectoration due to bronchitis or bronchiectasis (a 24-hour sputum is of value since the volume gives additional valuable information). On the other hand, nothing may be noted on examination other than an inflamed membrane, but the patient's handkerchief may reveal a purulent nasal secretion.

Other corroborative evidence may be obtained when in doubt by such laboratory procedures as blood count, sedimentation rate, nasal smear and X-ray examination of the sinuses and chest. In the majority of patients, however, the history and physical examination suffice. It should be continuously emphasized that the diagnosis of asthma per se (unless infective or of a mixed type) is not an indication for therapy with antibiotics. The indiscriminate use of aerosols of antibiotics for all types of asthma is not only fruitless but at times harmful. Nor should treatment of asthma be limited to treatment of infection, since it is well known that specific allergens or psychogenic factors or both may induce or aggravate this condition. A proper balance must be struck in analyzing the role of allergic, infectious, and psychosomatic factors in any given case in which a single or a combination of factors may be responsible.

Dosage and Duration of Treatment with Antibiotics. The dosage of the various antibiotics have varied, depending upon availability, whether used singly or in combination, and upon the acuteness of the condition. Early in these studies small doses of penicillin were given several times daily. Now, a large daily dose is the rule, except for the occasional case acutely ill, or where the bacteriologic studies show inhibition for a limited time only, i.e. temporary inhibition. A table of dosages is appended.

Treatment with the antibiotics for infection in the sino-respiratory tract should be continued until there is no further clinical

evidence of infection, as evidenced by the presence of the purulent secretions in the nose, throat or sputum. Following the termination of such evidence of infection, therapy should be continued, particularly in chronic cases, for a period of ten days to two weeks thereafter, in order to prevent a recurrence. The duration of treatment will vary, therefore, from patient to patient, depending upon the chronicity of infection and the nature of the organisms. Generally speaking, it can be stated that acute infections respond very readily to aerosols of antibiotics, where the antibiotic is selected on the basis of identification of the organism and the performance of inhibition tests. The response at times may be dramatic and within a matter of 24 to 48 hours there may be subsidence of the infection. This is particularly true where such organisms as the pneumococcus, or some variety of streptococci are found and where they are susceptible to one or more of the antibiotics. In other instances, however, where the infection has been chronic, and one is confronted primarily with an acute episode superimposed upon a chronic infection, or where the organisms identified are of the hemolytic staphylococci group, treatment will have to continue over a longer period of time. In contrast to the elimination of pneumococci and streptococci within a relatively short period of time, which can be demonstrated by bacteriologic methods, it is frequently very difficult to eradicate the hemolytic staphylococcus. Less frequently encountered are strains of hemolytic streptococci which are also resistant to therapy.

As will be indicated below, the application of bacteriologic methods is essential in the proper treatment of respiratory infection with aerosols of the antibiotics.⁴⁸ Indeed, the inhibition tests may also service in a diagnostic fashion. Where we have obtained by culture from the pharynx or sputum one or more organisms which are not completely inhibited by any of the antibiotics, the response to therapy has been difficult. Where only one of the five commonly used antibiotics shows activity there is apt to be difficulty in achieving the desired result. However, where sensitivity of a cultured organism is present to two or more of the antibiotics, the organism is more amenable to therapy. We have repeatedly encountered from patients suffering from chronic sino-respiratory infections, organisms which have shown by *in vitro* inhibition tests complete insensitivity to any of the antibiotics in common use, with a corresponding difficulty in response to therapy. Pending the availability of newer antibiotics, attempts at immunization should be made with autogenous vaccine in these cases.

SULFONAMIDE AEROSOLS

Prior to the advent of penicillin, the author following the footsteps of Castex et al,⁴⁴ Stacey,⁶ and Applebaum⁷ began to employ sulfonamides in the treatment of respiratory infections. The earliest observations from this clinic were reported with sodium sulfadiazine, and it was possible to demonstrate, following a single inhalation of a 5% solution of this substance (50 cc), the presence of sulfadiazine in the blood for six hours thereafter.¹⁰ There are, however, certain drawbacks to aerosol of sodium sulfadiazine. In solution it is quite alkaline, and subsequently attention was directed to studies with sodium sulfacetamide. This agent, provided through the kindness of Dr. Lehr, was adequately buffered in order to avoid any possible irritation as a result of alkalinity. Sodium sulfacetamide was used in the treatment of a limited number of patients and clinically it was effective to some degree. Subsequently, it was used in combination with penicillin.¹⁴ The studies with the sulfonamides were not continued in view of the fact that in vitro inhibition tests performed subsequently revealed that the sulfonamides as compared with the antibiotics were relatively poor agents against organisms isolated by culture from the pharynx. Thereafter, our attention was confined almost exclusively to the use of the various antibiotics as they become available.

Penicillin. With the advent of penicillin a new era began for aerosol therapy. Aqueous solutions were at first employed by us and were inhaled directly by the open method. Rapid absorption was noted by the serum analysis for penicillin, but this was of short duration (one to two hours). Attempts were made, therefore, to confine and conserve the aerosol for maximum utilization. The tent method and breathing box previously described were found very suitable for this purpose. When the aerosol of penicillin was stabilized by dissolving the drug in propylene glycol, and inhaled through the breathing box for approximately 20 minutes, highly effective blood levels of penicillin of six hours' duration were obtained.²³ Subsequently, it was revealed in control studies that the propylene glycol itself exerted some antibiotic action when reaching the blood. This could be demonstrated in vitro.⁴⁵ It was, however, an inconstant phenomenon as further studies revealed, and this phenomenon of propylene glycol serum action against the test organism (*B. subtilis*) could not be duplicated against many other organisms. Furthermore, subsequent studies with mice infected with a variety of bacteria apparently inhibited in vitro by propylene glycol-serum mixtures, could not be successfully treated with propylene glycol.⁴⁶

When penicillin was the only antibiotic available, it was used indiscriminately wherever evidence of infection was noted. This is no longer tenable in view of the limited action of antibiotics. The antibiotic chosen for therapy is now determined by culture and sensitivity tests.

Brief consideration is now given to the other antibiotics employed by the author in his practice.

Streptomycin. Like penicillin, streptomycin is readily aerosolized, and like penicillin it is readily absorbed from the lung as reflected by blood analysis.³⁹ Although we have employed streptomycin for non-tubercular disease, in view of the unusually high blood levels following inhalation, it would seem possible to employ this antibiotic for the treatment of pulmonary and possibly systemic tuberculosis. Streptomycin in the form of calcium complex has been used primarily in these studies. It is first dissolved in one or two cc of water and then added to approximately 18 to 20 cc of propylene glycol. The dihydrostreptomycin or other forms of streptomycin are insoluble in propylene glycol, producing an insoluble gummy mass.

Bacitracin. An antibiotic paralleling penicillin in many of its antibacterial properties, has been employed by us frequently in combination with penicillin since the two of them have been demonstrated to exert synergism.¹³ An aqueous aerosol of bacitracin is ordinarily difficult to administer since it acts as a detergent and produces a foamy solution. Furthermore, in aqueous form, when inhaled it is irritating to the pharynx. In addition, to some people it has an obnoxious taste and odor. However, when the vehicle employed is propylene glycol, all of these objections are eliminated. Bacitracin, although toxic by injection, is readily tolerated in aerosol form. It is not absorbed ordinarily through the lung so that its action is purely topical. It is a valuable antibiotic, non-toxic, and relatively non-sensitizing as compared with penicillin.⁴⁷ Occasionally, one encounters organisms sensitive only to bacitracin. Unlike penicillin, it is not inhibited by enzymes such as penicillinase, which makes it particularly valuable in mixed infections.⁴⁷ This antibiotic has, therefore, been advocated in instances where sensitivity to penicillin exists, or where the organisms are penicillin-resistant and bacitracin-sensitive, or where synergism is desired.

Terramycin. One of the newer antibiotics of wide range activity, terramycin has been employed by us successfully as an aerosol. No blood level studies have been made so it is not known as yet whether terramycin is absorbed through the lung. It is first dissolved in a small amount of water (one or two cc) and subsequently

this is added to 10-20 cc of propylene glycol as the vehicle. The aqueous solution of terramycin is highly acid and when employed as an aerosol is irritating to the mucous membrane of the respiratory tract. However, when dissolved in propylene glycol there is very little irritation. Possibly this is due to the suppression of ionization by the propylene glycol.

Aureomycin. Another antibiotic of great value, aureomycin, has so far not been employed in aerosol form since, like terramycin, it is highly acid in solution. Due to its relative insolubility and instability in solution, a useful aerosol of this antibiotic has not yet been developed.

Combinations of Antibiotics. As indicated previously, penicillin in combination with sulfonamides has been employed as aerosols. With the availability of a variety of antibiotics, it is now possible to employ them in various permutations and combinations. This is particularly suitable in sino-respiratory infections where a mixed flora is encountered. Such a procedure may also obviate the possible occurrence of a new infection following specific antibiotic therapy, due to overgrowth of an organism not inhibited by the antibiotic.⁴⁸ Furthermore, it may be possible to achieve some degree of synergism with these combinations, although Jawetz has warned about possible antagonisms between antibiotics.⁴⁹ Prigal and Furman,¹³ employing a combination of penicillin and bacitracin in aerosol form in the treatment of sino-respiratory infections, observed superior results with the use of this combination as compared with the use of penicillin alone.

FUNGICITIC AEROSOL

It has been demonstrated that frequently following the use of the antibiotics there is an overgrowth of monilia; at times this assumes pathologic proportions.⁵⁰ We recently encountered one such case, and have employed sodium caprylate which was introduced as an aerosol by Keeney for the treatment of bronchial monilial infections.⁵¹

ANTI-HISTAMINE AEROSOL

The clinical usefulness of the antihistamines in aerosol form has not been of sufficient value to be adopted for general use in the practice of allergy. Aerosols of antihistamines are employed experimentally in evaluating their efficiency in counteracting the effect of histamine aerosol. Feinberg and Bernstein⁵² evaluated pyribenzamine as an aerosol in allergic conditions of the nose and bronchi, and in-

licated that a 2% solution may serve as an adjunct to other forms of therapy.

Our own experience has been limited to aerosols of benadryl, and this, given to a limited series of patients suffering from asthma, resulted in no improvement; therefore, the studies were discontinued.

MISCELLANEOUS AEROSOLS

Propylene glycol, Insulin and Cortisone. As has been indicated, propylene glycol has been used primarily as a vehicle. We did not consider its possible pharmacological activity on bronchial tissue. Dautrebande, however, has indicated that propylene glycol has bronchodilator activity.⁵³ This had not been noted in nine asthmatic patients treated by us for control purposes with propylene glycol alone, in comparing it with penicillin dissolved in propylene glycol. Although two of our control cases seemed to show some improvement, the majority of them did not. As a matter of fact, another two of the patients were definitely worse following inhalation with propylene glycol.

We have experimented as well with two of the hormones in aerosol form, insulin and cortisone capryllate. Insulin, which was limited to experiments with animals, was absorbed through the lung, but so poorly as not to be able to shock the experimental animal (rabbit), even though large doses up to 1000 units were administered to the animal in a closed chamber. Possibly the poor absorption was due to the relatively large molecular size of the insulin. It should be remembered that the lungs stem embryologically from the gastrointestinal tract, and since insulin is not absorbable from the gastrointestinal tract it is possible that the lung's capillaries exert the same selective action and do not permit absorption of insulin.²⁵

The use of cortisone acetate as an aerosol has been reported for the treatment of pneumonia, with striking relief of the pain and dyspnoea but without affecting the disease state.⁵⁴ Cortisone tricapryllate, more soluble than the acetate, has been used by us in one case of asthma, with negative results.

CLINICAL STUDIES

Observations on the clinical application of a variety of steam-generated aerosols including the antibiotics have been reported in detail elsewhere.^{13, 14, 24} Only a summary of the results will be given at this time. In view of the primary interest of the author in the field of allergy he has, therefore, treated infections commonly associated

with allergic conditions. These are usually sinusitis secondary to allergic rhinitis or to nasal polyposis, or seen in association with bronchial asthma. Another group of cases frequently treated are the so-called cases of "asthmatic bronchitis" in which the syndrome of asthma is produced purely on an infective basis without any apparent allergic factor.

It is futile to rely solely upon aerosols of bronchodilators for a cure of asthma. Relief of asthma by any medication does not solve the problem for the patient since it does not get at the root of the cause. It is possible, however, with the removal of a specific allergen or with the treatment of the specific infection or both, to achieve more desirable results in this condition. Furthermore, a psychologic approach may be indicated since patients develop a train of symptoms secondary to the asthma (somatopsychic), and in addition emotogenic factors can aggravate or continue the asthmatic state (psychosomatic factor).⁵⁵

As our interest in aerosol therapy, particularly in the use of antibiotics, increased, a variety of other infections of the sino-respiratory tract were treated. These included the common cold, treated not so much to combat the virus causing this illness but, as indicated below, to prevent the secondary invaders from producing the usual complications such as sinusitis, bronchitis or infective asthma in those people who are susceptible to these diseases. In addition, there were treated sinusitis (acute and chronic), tonsillitis, laryngitis, tracheitis, acute laryngo-tracheobronchitis, bronchitis, bronchiectasis, bronchial asthma, pneumonitis, fibrocystic disease of the pancreas associated with sinusitis and bronchiectasis.

As a result of our experience in the treatment of these conditions with aerosol therapy, we can make the following observations. First, that aerosols of antispasmodic agents such as aminophylline or isuprel, singly or in combination, are highly effective in controlling bronchospasm. Secondly, it is important to overcome the bronchospasm prior to treatment with specific antibiotics. Failure to do this leads to poor utilization of the antibiotic in view of the reduced vital capacity and, therefore, inadequate concentration of the antibiotic in the bronchial tract. It was demonstrated in one patient that a reduction of the vital capacity by one-half reduced the absorption of the penicillin to one-twentieth. Third, acute infections are more responsive to antibiotic therapy than chronic cases; and, fourth, that it is necessary to use bacteriologic methods in the selection of the antibiotic.

RESULTS OF THERAPY OF INFECTIVE ASTHMA

In the earlier investigations, when penicillin was limited, the total dosage administered was 500,000 units, and in the treatment of 86 patients 64% showed moderate or marked improvement. When the total dosage was increased to 1,000,000 units 82% of 92 patients reported equal improvement. With penicillin readily available and relatively inexpensive, present total dosage reaches into the millions of units. Treatment with 300,000 units at least once daily is given until all evidence of infection is cleared (the character of the sputum serves as a guide) and is continued for several days to a week thereafter.

Attempts have been made to use bacteriologic methods as a guide to termination of therapy, the goal being complete elimination of the organisms responsible for the disease. This has been possible in some instances in which Pneumococci or some strains of Streptococci were present, but not where the dominant organism has been the hemolytic Staphylococcus. Daily cultures of patients have been taken, which revealed the rapid disappearance of some organisms under treatment, usually in acute infections or acute exacerbations of chronic infections, but they have also revealed a persistence of the majority of hemolytic Staphylococci encountered. It is the hardiness of this and other organisms, plus a lack by the patient of factors grouped under "immunity" which results in chronic infections.

The persistence of these organisms in the respiratory tract, despite adequate treatment employing the bacteriologic methods advocated below, indicates the shortcomings of therapy with the antibiotics. Attempts should be made to improve the patient's "immunity" by therapy with vaccines, preferably autogenous.

Asthma in children is much more amenable to treatment where infection is a factor, since emphysema, pulmonary fibrosis, bronchiectasis and sinusitis are less likely to be present. In an analysis of 131 ambulatory patients treated with aerosols of antibiotics (penicillin or streptomycin or both) only 77.5% of 98 adults showed improvement compared with 84.8% of 33 children.¹⁴

In the studies with aerosols of combined penicillin and bacitracin, Prigal and Furman¹³ reported improved results in the treatment of infective asthma and other sino-respiratory infections, as compared with penicillin alone; thus, 85.6% of all patients showed moderate or marked improvement as compared to 73% improvement with penicillin alone, given in comparable dose. Synergism between these two antibiotics has been demonstrated by *in vitro* studies, and corroborated clinically.⁵⁶

Bronchitis and Bronchiectasis. These conditions have been successfully treated with aerosol therapy in the author's practice. Although most patients seen had allergic complications such as hay fever, perennial allergic rhinitis or asthma, which made therapy more difficult, it was possible to effect improvement by correction of the allergic state where it existed, and using combinations of ammonium chloride and aminophylline as an aerosol, followed by antibiotic aerosol therapy based on bacteriologic methods. Maintenance of the improvement is the chief problem. This may be furthered by the use of the prophylactic measures herein discussed, removal of contagious foci, vaccine therapy (in selected cases) and good hygiene, to re-establish the patient's well-being. Next to asthma, these two disease entities profit most from aerosol therapy.

Sinusitis. This condition, as the above, has been treated usually in association with nasal or bronchial allergy. Acute infections respond readily to aerosol therapy without alternate suction as advocated by Barach et al.⁵⁷ Chronic infections can be greatly relieved but there is most often a return to the original state after cessation of therapy. It has been possible to effect dramatic response in some cases, with corresponding changes as noted by x-ray, but this is not typical. Nevertheless, with the use of this method there has been a marked reduction of surgery in the nose and throat.¹⁴

Aerosol Therapy for Miscellaneous Disease States. (Atelectasis, Periostetis Nodosum and Sub-acute Bacterial Endocarditis). Unusual clinical experience with aerosols included the treatment of atelectasis in a child suffering from infective asthma. Following the removal of a mucous plug by bronchoscopy, in six hours there was a return of the atelectasis, and considering it undesirable to repeat the bronchoscopy, aerosol therapy was resorted to with the relief of the atelectasis. The treatment consisted of continuous steam therapy, followed by frequent inhalations with aminophylline and ammonium chloride. This was designed to overcome the bronchospasm and to help liquefy the mucous. In addition, ipecac was given orally to induce vomiting and the phenomenon of "tracheal vomiting," to dislodge the mucous plug. This therapy was successful, resulting in normal expansion of the lung.

Another interesting experience included the treatment of an unusual case, ultimately diagnosed as periarteritis nodosum or diffuse collagen disease. Among the many complaints and abnormal physical findings were several episodes of asthma, with myocardial failure, and marked edema of head and neck which threatened to suffocate the patient. This individual, we believe, developed these phenomena

as a result of sensitivity to sulfonamides. After many months of disability, during which time his life was in jeopardy, it was discovered that the patient had a complicating pansinusitis. Treatment was, therefore, instituted with penicillin aerosol through the breathing box with excellent results, which was reflected not only in the clinical improvement of the patient, but in changes in the sinuses demonstrable by x-ray. It could not be ascertained for certain that it was the antibiotic therapy alone which resulted in the marked clinical improvement of this patient, since simultaneously arsenic (sodium cacodylate) was given to this patient intravenously. In view of the newer knowledge of possible stimulation of the adrenals by arsenic to produce cortisone, it is conceivable that the enhancement of cortisone production may also have contributed to the recovery of the patient. Suffice to say that now, five years after the therapy, the patient is still alive and able to perform rigorous manual labor as a machinist. He has, however, recently shown some progress of the disease by the appearance of microscopic blood in his urine and an elevation of his blood pressure.

In view of the blood studies performed with penicillin as an aerosol, in which it was revealed that penicillin can reach the blood in high concentration, an attempt was made to treat a form of bacteremia (sub-acute bacterial endocarditis) with penicillin in aerosol form. It should be recalled that this was during the early days of penicillin, and that penicillin in those days was given at two-hour intervals by injection. The result was that many patients who were thus treated for periods of months complained bitterly of the frequent and painful injections. There was at that time no form of repository penicillin available. Four patients with sub-acute endocarditis were treated in this way. Two of these patients are still alive. It should be pointed out, however, that they were not treated exclusively by aerosol but that aerosol of penicillin was used to either supplement penicillin already given, or to replace the penicillin given by injection for periods of time. In one patient in whom aerosol therapy was given exclusively, it was impossible to demonstrate any penicillin blood level at any time following treatment. This phenomenon could not be accounted for. The same phenomenon of non-absorption was noted in this patient when sodium sulfadiazine was used as an aerosol. The patient was, therefore, subsequently treated with large doses of penicillin and streptomycin by injection. Following recovery and sterilization of the blood, the patient died of massive hemorrhages and embolli several months after discontinuance of therapy. On other patient who subsequently died of chronic nephritis was successfully treated with penicillin, both by injection

and inhalation. For periods of time it was possible to maintain this patient's blood level with high concentrations of penicillin when administered as an aerosol, given several times during the day through the breathing box. Injections were resorted to at night because of expedience. Sterilization of the blood stream of the infective agent was demonstrable in this patient.

The two patients who now survive following treatment with aerosol therapy included one man who developed sub-acute bacterial endocarditis following an upper respiratory infection with subsequent pan-sinusitis. Aerosol therapy was, therefore, indicated for two purposes, both to control the sinusitis and to supplement the penicillin which was being given hypodermically and intravenously. It could be demonstrated in this patient that an inhalation of penicillin as an aerosol in suitable doses would double his penicillin blood levels, when an aerosol treatment followed the injection of penicillin. The patient is still alive after five years of discontinuance of therapy. The fourth patient was treated in a similar manner although he did not have any sinusitis. The patient was treated for a good part of his illness only with penicillin aerosol during the day, and with injections of penicillin at night. Aerosol therapy for sub-acute bacterial endocarditis can no longer be advocated in view of the availability of penicillin in repository form.

FAILURE OF AEROSOL THERAPY WITH ANTIBIOTICS

When we have failed it was due, first, to improper dosage or discontinuance of therapy too early; secondly, failure to use the proper antibiotic (subsequent tests revealing an organism not sensitive to the antibiotic being used); thirdly, failure to take full cognizance of two other factors commonly seen in my type of practice, namely, specific allergy and, at times, psychologic factors which aggravate or continue some of the symptoms commonly associated with sino-respiratory disease, particularly asthma.

Another deterrent to the achievement of good results, as will be demonstrated later, is the fact that we encounter in some individuals either a continuous infection or bouts of repeated infection (reinfection) which can be related to the presence of a carrier within the family state. This has been noted particularly in children, and it has been possible in some instances to improve the infection in a child by the treatment of one or more relatives with whom the child is in close association, and who are apparently immune and reinfect the patient.¹⁴ In searching for other possible sources of reinfection, we have encountered in the past few years instances of "harmless"

blepharitis or mild chronic conjunctivitis which apparently acts as a source of reinfection, since cultures taken from the eye seem in these instances to be identical with those cultured from the pharynx.⁵⁹ It is, therefore, obvious that the eradication of the infection in and about the eye is also important in the treatment of these patients.

In one instance, failure of therapy resulted from the presence of a hemolytic *Streptococcus* and hemolytic *Staphylococcus* which adapted itself to each antibiotic as used, finally developing complete insensitivity to each of the following antibiotics after adequate use: penicillin, bacitracin, streptomycin, aureomycin and terramycin. Fortunately, this phenomenon is not common.

AEROSOL THERAPY FOR INFANTS AND CHILDREN

Aerosol therapy with the antibiotics deserves special consideration as a form of therapy for respiratory infections in infants and children. It is possible by this method to obviate injections. Furthermore, if it is the purpose to achieve a high concentration of antibiotics in the area where it is most desired, namely, the respiratory tract, this should obviously be a method of choice. The problem in the past, however, has been of developing methods suitable for this purpose. It is impossible to expect young children or infants to sit and inhale the aerosol as produced. Since the introduction of the steam generator and aerosolizer, followed by the utilization of propylene glycol for the production of sustained aerosols, it has been possible to utilize aerosol therapy in infants and children by the use of either a tent, or by confinement within a small chamber which in the home has been the bathroom. Although a special tent was originally designed for this purpose, it is possible to merely drape the bed with sheets in such a way as to confine the aerosol for that purpose. Originally, we enclosed the patient entirely within the tent, leaving a small opening for purposes of adequate ventilation. It is possible, however, to leave one wall completely open and, provided there is no draft, to blow the aerosol into the confines of the tent. The antibiotics are thus used in this fashion.

Our attempts to introduce aminophylline as an aerosol for infants, administered by the tent method, have so far been fruitless. Possibly this may be due to the rather small dosage utilized. In the treatment of acute laryngotracheo-bronchitis it would seem to the author that the use of steam provided by the steam generator and aerosolizer would be particularly effective, and furthermore, that the use of ammonium chloride and other mucolytic agents, as well as antispasmodic agents should enhance therapy. Our experience in the treatment of these cases has been limited.

The closed chamber or bathroom method of treatment deserves special consideration in view of its usefulness in treating infants and children at home simply, conveniently and economically. It is administered by one of the parents confined with the child in the bathroom; one selects the parent who may display clinical or bacteriologic evidence of respiratory infection, thereby helping the parent and at the same time removing a source of reinfection for the child. (The implication of the carrier state and its significance will be demonstrated later). The disadvantage of the method is that larger doses of the antibiotic must be used since it is disseminated into a relatively larger chamber than the breathing box, and two people are being treated instead of one. Nevertheless, it is an efficient method and has proved of value, as indicated below. The efficiency of the method is enhanced by adequate pre-heating of the bathroom to prevent condensation of the aerosol. This is done by filling the bathtub with hot water prior to treatment. The addition of 1 or 2 cc of glycerol to the propylene glycol solution of the antibiotic maintains the aerosol for as long as one hour, if desired.

Bacteriological studies in the bathroom filled with propylene glycol-penicillin aerosol, in which seeded plates were exposed every ten minutes for ten minutes during a one-hour observation period, indicated that penicillin remained suspended in the atmosphere for at least 40 minutes. Control studies in which propylene glycol and glycerol without penicillin were used resulted in overgrowth of all exposed plates. This eliminates the possibility that the well-known sterilizing effect of propylene glycol was responsible for the lethal action on the seeded organisms (a strain of penicillin-sensitive *Staph. aureus*). This was anticipated since propylene glycol vapor or aerosol exerts its effect primarily in an atmosphere of low humidity.¹⁴

Prophylactic aerosol therapy. The author has been impressed particularly in his observations of infective asthma, that frequently there is a delay in the appearance of symptoms following the onset of a cold. This delay can serve as an interval for active aerosol therapy, in order to prevent the appearance of the symptoms of asthma due to infection. Thus, when the patient begins with the common cold due to the activity of a virus or viruses, if treatment is instituted at this moment it is possible to suppress the bacterial phase or the secondary invaders which complicate the cold and produce the symptoms which usually necessitate treatment.

Although this method has been applied primarily in the treatment of infective asthma, it should apply equally as well to those who suffer repeatedly from sinusitis, bronchiectasis, bronchitis and

allied disease conditions. Furthermore, the same principle should be applied to those who suffer from rheumatic fever, glomerular nephritis and other systemic diseases affected adversely by the secondary infections or allergic reactions or both resulting from the common cold and its complications. The method as employed by us, in which penicillin has been the primary agent, has been highly efficient. It should be remembered, however, that the antibiotics do not cure colds; they merely suppress the bacterial phases of the cold, thereby avoiding the secondary complications. In a recent report of 131 asthmatic patients¹⁴ treated in the office, 37 availed themselves of prophylactic therapy, and of these 35 (95%) avoided asthma. In several patients prophylactic treatment was given with success several times a year. In one instance it was successfully given seven out of eight times within two years. It is important to begin early during the viral phase of the cold, before the appearance of purulent secretion which is evidence of the second or bacterial phase of the cold. When purulent secretions are present, more prolonged treatment is necessary and asthma may not be avoided. For prophylaxis we had administered 100,000 units of penicillin through the breathing box once daily for three days. For the younger child we recommend 200,000 units of penicillin administered in the bathroom once a day for three days. Larger doses (300,000 units daily) are now recommended in view of the availability and inexpensiveness of penicillin.

THE APPLICATION OF BACTERIOLOGIC AND EPIDEMIOLOGIC
METHODS IN THE TREATMENT OF SINO-RESPIRATORY
INFECTIONS WITH SPECIFIC AEROSOLS

It has become increasingly necessary to develop a proper method for a choice of an antibiotic for any specific infection. This is due, first, to the multiplicity of the antibiotics now available, and one is confronted with the question of which one to employ. Secondly, it has become clinically evident that the arbitrary choice of an antibiotic may not be fruitful of results. For these reasons the author, in collaboration with Molomut, has employed a procedure for culturing the organisms encountered in sino-respiratory infections, and performing in vitro inhibition or sensitivity tests on these organisms with the various antibiotics as available. Details of this method and the results obtained have been previously reported.⁴³ A second series has just been concluded.⁵⁹ At this time it would be germane to summarize the findings of both series.

In the original studies the following antibiotics were used for the purpose of performing inhibition tests: penicillin, bacitracin,

streptomycin, aureomycin and chloromycetin. Two hundred twenty-five pharyngeal cultures were obtained from 163 patients suffering from sino-respiratory infections. This netted 583 culture isolates, of which 564 were subjected to the inhibitory action of penicillin, bacitracin and streptomycin. Subsequently, aureomycin and chloromycetin, as they became available, were added to the battery of testing agents, and 164 culture isolates were tested with these in addition to the aforementioned antibiotics. In the second series, 174 cultures were obtained from patients from whom 332 additional isolates were available. These were subjected to the inhibitory action of penicillin, bacitracin, streptomycin, aureomycin and terramycin. The latter was added in view of its wide range activity, and chloromycetin was dropped because in the original series it had shown relatively poor *in vitro* action.

It was possible to observe, as a result of the first series of studies that, although the antibiotics overlap in their *in vitro* activity against the organisms encountered in sino-respiratory infections, they also exert limited exclusive action. This was noted for all antibiotics except chloromycetin. A number of organisms (1.8%) were also encountered, however, that were completely insensitive to the antibiotics as employed by us.

In the epidemiologic aspects of the first study, 43 persons in 17 family units were cultured 68 times and 159 organisms isolated and identified. These studies revealed the possibility of the existence of a family source of contagion in ten of the 17 families studied. It was indicated that this may account for the repeated reinfection, or for chronic infection of the sino-respiratory tract.

The second series of bacteriologic and epidemiologic studies was designed to note, first, whether there was any change in the bacterial flora of patients encountered with sino-respiratory infections as compared with the original observations. Secondly, to re-evaluate the antibiotics previously tested and to compare these with terramycin, a new and potent antibiotic, simultaneously noting whether or not antibiotics retain their efficiency with continued use, and whether there is development and dissemination of resistant strains. In addition, the evidence obtained about the carrier state was investigated further, thereby accumulating additional data to corroborate the earlier findings.

As a result of these studies, it was indicated that there was a striking and fundamental change in the flora of patients presenting themselves for treatment because of sino-respiratory infections. Whereas, in the original series, it was noted that non-hemolytic

Streptococci and *N. catarrhalis* were the dominant organisms, the second series revealed that hemolytic Staphylococci and Streptococci were dominant. It is most likely that this change in the flora is due to the increased use of antibiotics and to the development of resistant organisms. Whereas the original series showed 1.8% of all organisms not inhibited by any of the antibiotics, the second series showed an increase of 100% (3.9%), and this was obtained in spite of the fact that terramycin had been added in the second series. In comparing the action of penicillin, bacitracin, streptomycin and aureomycin in the first and second series, it was noted that all of the antibiotics had lost some efficiency, the most striking being aureomycin. Terramycin rated as the most effective antibiotic, at least by in vitro tests, but this may be due to the fact that terramycin is still relatively new and has not been as widely employed as the other antibiotics. It is conceivable that this antibiotic will follow the tendency of the others and will ultimately lose its efficiency.

Upon analysis of the total number of organisms inhibited by the antibiotics, and the number uninhibited, it would appear that there is still a large area of organisms unaffected by the present antibiotics, and that a search for additional new antibiotics is indicated; or that the possibility of using combinations of antibiotics should be investigated. Furthermore, attempts should be made to investigate the means whereby organisms develop resistance, with the hope that this tendency might be reduced or reversed.

In the epidemiological studies of the second series, 22 families were investigated, in 17 of which evidence was encountered of contagion or the carrier state or both. This series was more representative of the family, and consisted of instances in which families of four or five members were investigated. In the families studied completely, 11 out of 12 showed evidence strongly suggestive of contagion, whereas in the incomplete family group six out of ten showed such possible contagion. In some of the families three out of five members had identical organisms. This not only included a single organism but at times even two or three organisms, with most members of the family exhibiting all these organisms. An analysis of the organisms involved implicated hemolytic Staphylococci 14 times, hemolytic Streptococci seven times, and a combination of these two, two times. In one instance a combination of hemolytic Staphylococci and *H-influenzae* were noted. Altogether (series 1 and 2) 39 families were studied, of which 26 showed some evidence of the existence of a carrier state. It should be emphasized that not all members of a family were investigated. Were the investigation to

have been carried on inclusive of every member of the family, it would seem that incidences of the carrier state might conceivably have been higher.

DISCUSSION

Aerosol therapy has definite value and limitations. It has been the purpose of this symposium to discuss and define the proper sphere of aerosols in medical practice. It appears to us that certain obvious errors are committed by those who are inexperienced in aerosol therapy. First, they do not choose the proper apparatus so that the aerosol particle is not of the proper size to achieve its purpose.⁶⁰ Aerosols intended for deeper penetration into the lung should be within the range of 1 to 2 micra.³³ On the contrary, should one desire to treat pharyngitis or laryngitis, a particle range of 5 to 10 micra would be better.³⁶ It would be incorrect to reverse the procedure and failure would result. Secondly, errors are made with the use of antibiotics in employing them intermittently, every other day or even once weekly. Such a procedure can not only result in failure but in possible aggravation due to the production of resistant organisms. Thirdly, it is impossible to employ any antibiotic by random choice with the assurance that it will succeed, since it is known that each of the antibiotics at times exerts only exclusive action, and that there are organisms which are completely insensitive to any of the common antibiotics available.^{43, 59}

Aerosol therapy is only in its infancy, and there is no question that as research work is conducted in this field, a variety of aerosols hitherto unthought of will find use in the treatment of sino-respiratory infections, and possibly even for systemic diseases as indicated below.

There is sufficient evidence to indicate that aerosol therapy with antibiotics has special merit in the treatment of sino-respiratory infection, because of the local deposition in high concentration of the therapeutic agent. Nevertheless, the classical experiment has not yet been performed in which parallel series of cases are treated in alternate fashion by the aerosol method, and by oral or intramuscular routes with adequate controls conducted as to the method of observation, and use of placebos. This would settle once and for all the debate as to whether or not aerosol therapy is superior to other approaches in the treatment of sino-respiratory disease. For the author, although this experiment has not yet been performed, aerosol therapy has certainly demonstrated its usefulness in that the instances of surgery resorted to in the sino-respiratory tract have been reduced

markedly in the past few years as compared with the years antedating aerosol therapy. Now, no surgery is performed on any patient showing evidence of sino-respiratory infection for any condition other than obstructive polypi. There are no more tonsillectomies, irrigation of the antra or operative procedures performed on any of my patients.¹¹

Sino-respiratory infections have a tendency to become chronic. It is, therefore, germane to consider this problem which has many facets, and the role of aerosol therapy. In the first place, the surface and invaginations of the mucous membranes are such as to make complete sterility impossible. Secondly, the type of flora which appears in the respiratory tract may be conducive to chronic infection, particularly where streptococci and staphylococci are concerned. Some strains of these organisms are exceedingly hardy and resist destruction, either by the forces generated by the host or by the powerful antibiotics administered in an attempt to control infection or both. Furthermore, it should be recalled that the organisms found in patients possibly reflect the organisms in the atmosphere to which he is exposed. Opportunity for reinfection is constant, the hazard being greater during the "cold season." Then again, infection may be maintained by such innocent infections as chronic blepharitis or chronic conjunctivitis. Evidence has also been presented of the role of the carrier within the family in the production and maintenance of chronic respiratory infection. It is possible to indicate that certain organisms, usually the hemolytic *Staphylococcus* and *Streptococcus*, have a tendency to settle and to stay within the family group, despite all treatment.⁵⁹ Indeed, so difficult is it to eradicate these organisms that the question is raised as to whether or not, in addition to therapy with antibiotics, the approach should not be directed toward improving the "immunity" of the patient in order to combat and overcome, or to hold in abeyance, infection.

Disease in the sino-respiratory tract should not be looked upon as a static phenomenon. It is highly kinetic in the sense that forces for dissemination and aggravation are always at play, as are counterforces designed to control the infection. It is common knowledge, for example, that a virus infection will so alter the balance of forces that the equilibrium is shifted against the host. That is due to the fact that the viruses apparently stimulate activity on the part of dormant organisms normally present in the sino-respiratory mechanism. Latent disease is, therefore, converted into active disease. The administration of antibiotics reverses the equilibrium favorable to the host. It is possible that with the use of vaccines immunity of the host may be so enhanced as to prevent infection.

In view of the above, the value of aerosols for prophylactic purposes deserves more consideration than has been given in the past.⁶¹ In the experience of the author, it is possible to institute aerosol therapy with antibiotics early during the viral phase, thereby preventing the secondary bacterial phase from producing the usual complications of sinusitis, bronchitis, infective asthma, bronchiectasis and pneumonitis.¹⁴ These views have been shared by Finke⁶² who believes that adequate aerosol therapy in children suffering from repeated mild respiratory infections may prevent the later chronic complications such as chronic bronchitis and bronchiectasis. Taplin and associates have also advocated antibiotic therapy in order to prevent postoperative respiratory infections.⁶³

In considering therapy with solid aerosols (dust, powders), there have been those who advocate this form exclusively.^{27, 28} Others have favored exclusive use of liquid aerosols.⁶⁴ It would seem that this either/or approach is incorrect since there are specific values and limitations for each of these types of aerosols. Powdered aerosols offer a relatively simple method of introducing an aerosol, making it particularly suitable for prophylactic purposes. There are specific limitations, however, to powdered aerosols which should be considered. The first limitation is that the availability of the aerosol depends upon humidity. A highly humid climate or a change to a high humidity in less humid climates causes sufficient adhesion between particles so as to prevent the formation of an effective aerosol. In addition, electrostatic charges upon these powders must be considered, since it is possible to have the particles so charged that they neutralize and attract each other and conglomerate into large masses, thereby making it unsuitable for therapy.⁷⁷ At times the taste of the substance makes it useless for aerosol therapy in powder form, or at least obnoxious. This is particularly true for aminophylline. At other times the powder has such hygroscopic properties that it must be treated with agents in an attempt to prevent it from caking. This dilutes it to such a degree as to defeat its original purpose which was to permit only the prime substance in high concentration to be inhaled. The incidence of allergic reactions seem to be greater with powders in the case of penicillin. Furthermore, a form of therapy which is readily available is relatively dangerous (to certain patients), since they know no limits for its use, and, in the case of aerosol of isuprel which is frequently given in a concentration as high as 25%, it is possible to produce very serious and disturbing side reactions, such as apprehension, precordial distress, dizziness and tachycardia.

Although most of these objections can be overcome with liquid aerosols, this too has its shortcomings in that it is considerably more

cumbersome than the simple methods developed for the use of micro-nized "dust" aerosols. Furthermore, it is doubtful whether liquid aerosols are utilized as completely as the powdered form, in view of the fact that the aerosol is usually produced in greater concentration than it is possible to inhale. To overcome this, one either inserts a demand type of valve in the apparatus, further complicating the method of its administration or employs a closed system or uses both, to avoid loss and dissemination of the agent. With the passing of time it will be determined which materials and for which diseases it would be most suitable to use the powders, and for which it would be most suitable to use liquid aerosols.

Depth of Penetration of Aerosols. The relationship of the particulate size of the aerosol to its penetration into the lung has been adequately discussed by Findeisen,⁶⁵ Van Wigh and Patterson,⁶⁶ Rooth,³³ Abramson,⁶⁷ and others, and will not be entered into detail. They all agree that particles from 1 to 10 μ could be traced into the alveolae, and that the optimum size for deep aerosol therapy should be around 1-2 micra. The larger particles have a tendency to be precipitated in the pharynx, trachea and larger bronchi. The extremely small size particles are not precipitated at all and are exhaled. (This conclusion was challenged by Bonelli of Turin, who contends that the methods used in measuring the size particle were inadequate.) It is, therefore, important to obtain the correct size of aerosol particles for maximum efficiency. Only one group of observers have indicated that they could not find any evidence of penetration of an aerosol deep into the respiratory tract.⁶⁸ Several possible explanations of failure to note penetration into the alveolae may be offered. In the first instance, aqueous aerosols were produced, and since these are absorbed rapidly in the respiratory tree it is possible that they were absorbed too rapidly to be observed. Secondly, the nebulizer which was used (Glaseptic-P. D. & Co.) has, in the experience of the author, not been as adequate in the production of aerosols as either the vaponephrine or the DeVilbiss nebulizers. That penetration in sufficient amount into the deepest parts of the lung does take place has been evidenced by indirect and direct observations. It has been possible to prevent tuberculosis in guinea pigs by the use of promin as an aerosol, as demonstrated by Barach et al.⁶⁹ Likewise, Wilson⁷⁰ and her collaborators, in their studies on pneumonia, have been able to obtain equal results with aerosol therapy in their experimental animals as compared with penicillin given by injection. In studies with sulfonamides, Chapple,⁸ and Prigal¹⁰ have both been able to demonstrate effective blood levels. Indeed, both have demonstrated the possibility that the lung may act as a depot

retaining material inhaled by aerosol and slowly giving it off to the blood stream. Studies with penicillin as observed by Bryson,⁹ Barach,¹¹ Prigal,²³ Segal¹⁶ and others, which reveal high blood concentration following inhalation, also indicate that there must be deep penetration into the lung of a given aerosol. It is impossible to have rapid and complete absorption such as noticed in these studies, through the relatively small surface area of the pharynx, trachea and the large bronchi. The rapidity of absorption of an aerosol as observed by Prigal,²³ and by Talbot, Quimley and Barach,⁷¹ utilizing radioactive sodium chloride, implies that the absorption took place in the alveolae, since it is only there that one finds the necessarily large surface and the thin membrane through which such tremendous and rapid absorption would take place. It is germane at the moment to indicate that the surface of the lung including the capillary bed is approximately 700 square feet, that there are 300,000,000 alveolae, and that the capillary wall is 1/30,000th of an inch in thickness.⁷² All of these factors enhance absorbability.

The most convincing evidence, however, is presented by the direct method of the observation of an aerosol deposited within the alveolae. Such experiments have been described by Rooth³³ utilizing sodium fleurosine, and by Kreuger and co-workers,⁷³ who nebulized a solution of radioactive chromate phosphate into the lungs of monkeys and obtained autoradiographs when applying sections of the lung against sensitized film. A similar experiment was performed by Hamilton,⁷⁴ in which he used an aerosol of plutonium oxide, subjecting the sectioned lung to the autoradiographic technique. Plutonium oxide is so insoluble that this material could be found within the alveolae 24 hours after cessation of inhalation, whereas all the bronchi including the terminal bronchi had been completely emptied by the ciliary mechanisms of the lung.

Consideration of the depth of penetration of the lung by an aerosol is not purely academic, since upon it rests the possibility of the use of the lungs as a means of introducing medication for systemic effect, and of introducing radiopaque material in aerosol form in order to outline the bronchial tree. These will now be considered.

The Use of the Lung as an Avenue for the Introduction of Medications for Systemic Effect. Sufficient evidence has already been presented in this paper to indicate that some materials are rapidly absorbed from the lung. In view of the fact that the lungs are really an outgrowth of the gastrointestinal tract, it is conceivable that it may have similar functions. As reported by this author,²⁵ the

resemblance in activity between these two organs is striking. It would seem that just as the gastrointestinal tract has selective absorption, so has the respiratory tract.

Although the author,²⁵ and Gaensler, Beakey and Segal¹⁸ have made some contributions in this field, it is apparent that a major effort is as yet to be made in determining the factors which control absorption through the respiratory tract. This information would be of importance, since it is possible to introduce some medications in this fashion through the lung and directly into the blood stream without passing through the liver, which frequently alters or modifies a given agent, thereby destroying its effectiveness. Furthermore, some material altered or destroyed by the gastric juices might conceivably be introduced in this fashion. Then again, this could be used as a substitute for the intravenous route for some medications, without the necessary trauma and other cumbersome procedures associated with an intravenous injection. Another point in favor of aerosols is the possibility for self-administration.

Diagnostic Aerosol. In consideration of the possible use of aerosols for diagnostic purposes, it has been logical to think of it primarily in terms of outlining the bronchial tree with radiopaque substances. An attempt was made by the author in association with Wolf and Hodes to achieve this by the use of potassium iodide, both in aqueous and solid aerosol forms, and by the inhalation of nebulized iodized oil (Iodochloral)⁷⁵ The results, however, were completely negative in that human subjects exposed to aerosols of these agents revealed no deposition of the radiopaque substance demonstrable either by fluoroscopy or by x-ray performed immediately after inhalation. The most likely explanation for this is that in the attempt to produce deep penetration, the particulate size is so reduced that absorption is enhanced to the degree that little or none of the radiopaque substance is present to produce an x-ray effect. Furthermore, relatively small quantities can be administered as an aerosol as compared with instillation, and its dissemination is so great if it is to cover 700 square feet of surface that it would necessarily result in an inadequate concentration of radiopaque substance capable of demonstration by x-ray, assuming no absorption is taking place. It would seem that the ultimate solution to this problem would lie in the use of a new type of radiopaque material capable of producing shadows in smaller concentration than the iodides commonly in use. Furthermore, the vehicle would have to be one which would permit clinging and adhering to the surface of the bronchial tree without permitting too rapid absorption. No such material is as yet available. It should be pointed out that the studies of Farinas⁷⁶ in which

he outlined the mucosa of the upper bronchial area, was achieved not by aerosols but by a spray of relatively large size particles. This is not aerosol radiography but is mucosography, and is not suitable for outlining the finer ramifications of the lung.

In conclusion, consideration should be given to the possible use of aerosol therapy on a mass basis. It is known that in chemical or bacteriological warfare or both, aerosols or mists of toxic agents can be employed. Therefore, countermeasures must likewise be considered. Aside from this, as the author has shown, it is possible with the use of the bathroom technique, which could readily be expanded to incorporate large rooms or barracks or wards, to treat several people simultaneously. With an adequate apparatus, and with the use of a suitable vehicle, it is possible to so alter or modify the atmosphere as to provide a constant therapeutic aerosol for inhalation for many hours during the day and at night. Prof. Guassardo of the University of Turin has already achieved this and demonstrated his aerosol chambers at the meeting in Turin (June 1 and 2, 1951). In a similar fashion it might also be possible to employ aerosols of non-toxic material capable of sterilizing the atmosphere in order to prevent respiratory diseases.

SUMMARY

1. An apparatus for producing aerosols with steam is described, and methods of application of the aerosol are considered.
2. An historical review of the development of aerosol therapy in the United States is presented.
3. The application of aerosols of mucolytics, bronchodilators, antibiotics, antibacterial agents, antihistamines and other agents is described.
4. A description of the clinical application of the various agents to the various disease entities is described. The disease conditions emphasized include asthma, bronchitis and bronchiectasis.
5. A description of the bacteriological and epidemiologic approach to the treatment of sino-respiratory disease is given.
6. Discussion is presented as to the possible use of aerosols for diagnostic purposes, and as a means for introducing medications into the lungs, not only for local action but for systemic action as well.

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55 PARK AVE.

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TABLE 1.—SUGGESTED DOSAGE SCHEDULE FOR AEROSOL ADMINISTRATION.

TYPE OF DRUG	MEDICAMENT	METHOD OF ADMINISTRATION	DILUENT	AMOUNT/DOSE	FREQUENCY OF ADMINISTRATION
Antispasmodics	Aminophylline	Open inhalation	H ₂ O	0.25 to 0.5 Gm in 10-20 cc H ₂ O	1-3 x d.
	Isuprel	Open inhalation	H ₂ O	1-2 cc of a 1-200 solution in 10 cc H ₂ O	1-3 x d.
		Open inhalation	H ₂ O	50-100,000 units in 10-20 cc H ₂ O	2-3 x d.
Antibiotics		Tent method	Propylene glycol 18 cc and 2 cc glycerine	100-300,000 units	2-3 x d.
	Penicillin	Closed chamber (bathroom method)	Propylene glycol 18 cc and 2 cc glycerine	200-400,000 units	1-2 x d.
		Breathing box	Propylene glycol 20 cc	50-300,000 units	1-2 x d.
	Streptomycin*	Breathing box	H ₂ O 1-2 cc and then add to propylene glycol (18 cc)	0.5 to 1.0 Gm	1-2 x d.
Mucolytics	Bacitracin	Breathing box	Propylene glycol	25-50,000 units	1-2 x d.
	Terramycin	Breathing box	Propylene glycol	.5 Gm	1-2 x d.
	Ammonium chloride	Open inhalation	H ₂ O	10 cc of a 5% solution	1-3 x d.

*DO NOT attempt to dissolve streptomycin (calcium complex) directly in propylene glycol, since this forms a gummy insoluble mass. Dissolve first in water and then add to the glycol.

FRACTURES OF THE FACIAL BONES—STANDARDIZATION OF DIAGNOSIS AND TREATMENT

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During the past century America has made great contributions in the field of medicine and surgery. Probably the greatest contribution has been the untiring effort on the part of teachers and practicing physicians to standardize diagnostic and therapeutic technics. This was well borne out in World War II, and as a result the American soldier was better cared for than soldiers in any previous war. There are still a number of medical and surgical conditions, however, for which standardized diagnostic and therapeutic technics are wanting. Probably no surgical condition so well exemplifies this need of standardization as does that of fractures of the facial bones.

In 1947, Fenton¹ wrote an excellent brief history of otolaryngology from 1847 to 1947. He stressed the great effort on the part of teachers to standardize methods of teaching and mentioned the many standardized technics which have resulted. His failure to include the problem of fractures of the facial bones suggests that his reason may have been a feeling of lack of uniformity and standardization in this field.

The literature is filled with individual methods and appliances for reducing fractures of the facial bones. No doubt all of these have merit, particularly, in the hands of their inventor, but one finds the endeavor to integrate all these technics and appliances rather bewildering. It is, of course, taken for granted that the fundamental problem is one of reduction and immobilization, and by the same token it is assumed that the method used to attain this goal is of secondary importance. When, however, one surgeon insists on exploring certain fractures and another blindly wires the same type of fracture, there is obviously a variance in the concept of fundamentals. It is the purpose of this paper to point out some of the anatomic, diagnostic and therapeutic discrepancies that prevail and to suggest certain standardized procedures that may be used by all.

¹Presented as a candidate's thesis to the American Laryngological, Rhinological and Otolological Society.

HISTORY

The authors of ancient times were rather vague in regard to fractures of the facial bones. They apparently were more concerned with the healing of bone than with methods of reduction and immobilization. Hippocrates² made no mention of the periosteum and rejected the possibility of bone regeneration. Galen² advanced the theory of bone juice as a reparatory agent. Celsus² described in detail the operations performed on the bones for the purpose of removing or destroying the necrotic or carious portions, but did not actually mention regeneration. Fractures of the facial bones are referred to in the literature, and an occasional reference is made to reduction of fractures of the nasal bones by external pressure. The first experimental work one can find in relationship to fractures of the facial bones is that of Le Fort,³ a French surgeon. In 1901, he published a long treatise on all the various forms of fractures involving the upper jaw and upper part of the face. He described three distinct types of facial fractures, which Kazanjian and Converse⁴ referred to as Le Fort I, II and III. The Le Fort I type is a transverse horizontal fracture of the maxilla and is also known as Guérin's fracture.

Interest in fractures of the facial bones received a great impetus during World War I. Practically all the writing on this subject has been done in the twentieth century.

INCIDENCE

Fortunately, there is one opinion on which all authors writing on this subject during the past 20 years are agreed, namely, the increased frequency of fracture of the facial bones. They attribute this increase principally to the greater use of the automobile, airplane, motorcycle and motor scooter. Straith⁵ directed attention to the "guest passenger fracture" many years ago. He thought that the design of the automobile dashboard could be altered in such a way as to prevent many injuries of this type. It is interesting that several automobiles have come out with essentially the design he suggested more than 15 years ago.

Some steps have been taken along this line in the design of airplane panels. Military aircraft, however, are not designed for safety but rather for speed and performance. About the only safety devices to prevent facial injury are the seat belt and shoulder straps. It was my experience during World War II that the shoulder straps, when used, prevented many facial injuries. The shortcoming of the shoulder straps was that they were controlled manually by the pilot and he was supposed to lock them in position on taking off and landing.

Many times he failed to do so, and if not locked, they served no purpose whatsoever. Perhaps some automatic locking device would eliminate the weakness of this otherwise efficient device. With the present trend toward fast automobile driving and the increased use of the motor scooter and motorbike, there is little to lead one to believe that there will be any decrease in the number of fractures of the facial bones.

In the organization of the professional activities of the medical department during World War I, a section of plastic and oral (maxillofacial) surgery was created. Twenty-one specialists were first assigned to this section. This group was headed by Blair, a plastic surgeon, and Boak, an oral surgeon. To aid them in the organization and standardization of treatment were Hayes and Davenport of the American Ambulance in Paris; Morestini and Lemartre of the French Army; Kazanjian and Valdier of the British Expeditionary Forces; Gillies of Sidcup, and Cole of London.⁶

According to statistics⁶ compiled by the Surgeon General's Office, there were 1,636 cases of fracture of the facial bones in the American Expeditionary Force. A breakdown of this number is as follows; malar bone, 64; maxilla inferior, 1,123; maxilla superior, 323; nasal bone, 77; vomer, 20 zygoma, 29. Apparently malar bone refers to the body of the zygoma, and zygoma refers to the arch formed by the processus temporalis of the zygoma and processus zygomaticus of the temporal bone. It is noteworthy that between 800 and 900 of the patients in this series required further plastic surgery upon returning to the United States. This seems a rather high percentage to one in civilian practice however, one must take into consideration that wounds caused by high explosives often entail considerable loss of tissue. I was unable to elicit the incidence of infection, but it was undoubtedly high, probably over 50 per cent. Nevertheless, gas gangrene of these wounds, with the exception of those of the orbit, did not occur.

Erich⁷ observed; "As has been stated frequently, the nasal bones are more often fractured than are other bones of the face." I believe that this is the general conception, but the statement is hardly in keeping with the statistics of the Surgeon General's Office, namely, 77 nasal bone fractures among the 1,636 fractures of the facial bones. Gill⁸ stated: "The malar bone next to the nasal bones, is the facial bone most frequently fractured. . . ."

Leech, Drum and Osterhagen⁹ reported the experiences of a maxillofacial team approximately one year's work in a 400 bed evacu-

ation hospital in World War II, where the incidence of maxillofacial injuries was 7.1 per cent. Their report was based on the case records of 1,148 patients. A breakdown of the cases of fracture was as follows: Nasal bones, 76; mandible, 136; frontal, 16; ethmoid, 3; sphenoid, 3; maxilla, 94; zygomatic malar, 93; multiple associated fractures, as of the palate, ethmoid, vomer, turbinate and lacrimal bones, 128. These authors listed the zygomatic malar bone, apparently referring to one bone. Regarding the incidence of infection, they noted: "... superficial or stitch infection occurred in less than 5 per cent of the patients; no cases of cellulitis developed in the reported series."

Hilger¹⁰ concluded: "The nasal bones due to their prominent position are, perhaps, the most commonly fractured bones of the body." Slaughter and Wong¹¹ reported that in a series of 300 consecutive cases of fracture of facial bones treated in a civilian hospital, the incidence of fractures of the various facial bones was as follows: mandibular, 86 per cent; zygomatic, 5 per cent; transverse facial, 4 per cent; nasal, 2 per cent; condylar, 2 per cent; frontal, 0.5 per cent; coronoid 0.5 per cent. It is noteworthy that the malar bone is not mentioned. The transverse facial referred to by these authors is apparently a type of fracture rather than a facial bone.

Regarding the incidence of fracture of an individual bone, Brown and Fryer¹² expressed this opinion: "The zygomatic bone (malar or cheek bone) frequently receives the blow but is itself seldom broken." Straith⁵ stated: "Fractures of the mandible are the least frequently occurring type of jaw fracture resulting from automobile accidents."

The following statistical study was based on a series of 147 cases of fractures of the facial bones in which treatment was given at a local hospital during a five year period from 1946 to 1950: frontal bone, 28; nasal bone, 38; malar bone, 6; zygo-ma, 20; maxilla, 43; mandible, 40; sphenoid, 1; vomer, 1; ethmoid, 2. Of the six cases in which a fracture of the malar bone was diagnosed, in two the diagnosis was made by general surgeons, in one by an orthopedic surgeon, and in three the source was undetermined. Apparently, the term malar bone is being discarded by the otolaryngologist.

A review of the literature leads one to believe that there is a wide difference of opinion regarding the incidence of fractures of individual facial bones. On the other hand, if one confines himself to specific statistical analyses, he is impressed by the great degree of uniformity of the various studies.

ANATOMIC CONSIDERATION

In the anatomic consideration of this subject I shall first endeavor to answer the following question: What bones are the facial bones? A review of the literature indicates that there is a discrepancy in opinion among authors as to what bones constitute the facial bones. Many authors write at length on this subject, but at no time mention the frontal bone. Other authors write at length and mention the mandible only briefly. In the textbooks of anatomy and applied anatomy, it is rather difficult to find a classification of facial bones. In the twenty-first edition of "Gray's Anatomy,"¹³ published in 1924, there appeared the caption "The Facial Bones (Ossa Faciei)." Under this heading the following bones were listed: "The Nasal Bones, the Maxillae (Upper Jaw), the Lacrimal Bones, the Zygomatic Bone (Os Zygomaticum; Malar Bone), the Palatine Bone, the Vomer, the Inferior Turbinate, the Mandible and the Hyoid Bone." Many of the authors who have written on this subject consider the frontal bone, but it is not mentioned in Gray's classification. It is also striking that this list includes the inferior turbinate, the palatine bone, the vomer and the hyoid bone as facial bones, and yet they are seldom even mentioned in works on the subject. The authors apparently give this classification little serious consideration; instead, they prefer to write about the bones with which they have had the most experience and particularly the bones they choose to mention at the time. This course would be entirely fitting if it were not for the fact that almost universally the titles of their papers relate to fractures of the facial bones, in most cases referring to a new type of splint or some new procedure for the fixation of these fractures.

There is also a great discrepancy in reference to individual bones, particularly the zygoma. This is not at all difficult to understand when one refers to "Davis' Applied Anatomy,"¹⁴ published in 1926. From this textbook, used widely in medical schools, the following is quoted: "The Malar Bone is the most prominent bone of the cheek. It is such a strong bone and so strongly supported that fracture of it, as well as that of the Zygoma, is rare." A diagram depicting the isolation of the malar bone and the zygoma has this legend: "(a) Malar Bone sectioned above and below. (b) Dotted line represents the point at which Zygoma is divided with Gigly Saw. . . ." The dotted line indicates the suture line of the temporal process of the zygoma and the zygomatic process of the temporal bone. The only conclusion that one can draw is that the author referred to the body of the zygoma as the malar bone and the arch which is formed by the two processes as the zygoma. On the other hand, Gray¹³ and Spalte-

holz¹⁵ referred to the "Os Zygomaticum or Yoke Bone (O. T. Malar bone)," describing it in detail; they called the posterior process the processus temporalis and described it as uniting with the processus zygomaticus of the temporal bone. Spalteholz¹⁵ listed the bones of the face as follows: "The bones of the face are 14 in number, there being two single bones and six pairs. The single bones are the Mandible, or Inferior Maxilla, and the Vomer; the pairs are the Superior Maxilla, Malar, Nasal, Palate, Lachrimal, and Inferior Turbinated Bones."

In keeping with an effort to standardize the treatment of fractures of the facial bones, it seems wise first to standardize the terminology of the bones involved. In my opinion, it would be highly desirable to drop the term malar bone and refer to this bone only as the zygoma. If, however, one desires to retain this term, it should be clearly understood, as set forth by Spalteholz,¹⁵ that malar bone is the old term for zygoma and that the two are one and the same. In contemplating the enumeration of the bones to be referred to as the facial bones, one should first take into consideration the basis upon which to consider these bones. Should they be the bones which produce man's physiognomy? Should they be the bones which are most vulnerable to injury? Or, should they be the bones which it is most feasible to attack surgically? It seems fitting to consider the bones which make up man's physiognomy and which, when fractured, will alter the facial contour. It also seems logical to consider the bones which are apt to be involved when the more superficial bones are fractured. I shall therefore refer to the following as the bones of the face: Single Bones: (1) Mandible or Inferior Maxilla, (2) Vomer, (3) Ethmoid, (4) Sphenoid, (5) Frontal. Paired Bones: (1) Superior Maxilla, (2) Zygoma, (3) Nasal, (4) Palatine, (5) Lacrimal, (6) Inferior Turbinates.

In viewing the dry skull it becomes obvious that the maxilla, the palatine bone and the zygoma are so firmly attached at their suture lines that in the study of fractures they may be considered as one bone. It also becomes manifest that this bone, the zygo-palatine-maxillary bone, is attached to the skull at four points: (1) to the frontal bone by the ascending process of the maxilla; (2) also to the frontal bone and greater wing of the sphenoid by the frontal process of the zygoma; (3) to the pterygoid process of the sphenoid by the palatine bone; and (4) to the temporal bone by the temporal process of the zygoma. If the skull is rotated, it is not difficult to visualize these four points of attachment as lying in a common plane, approximately 45 degrees to the horizontal. Thus the middle third of the face is

attached to the skull at eight points, all of which lie roughly in the same plane.

In reviewing the literature I find that there has not been a great deal written pertaining to the mechanics of the fractures of the facial bones. Le Fort,³ in 1901, performed some experiments in an effort to determine what fractures one could anticipate as a result of various blows to the human face. In 1942, Naftzger¹⁶ performed similar experiments and reached essentially the same conclusions as Le Fort.³ The Naftzger experiments were as follows:

"1. Force was applied directly to the lateral surface of the malar, resulting in dislocation of the malar from the frontal and zygoma. There was a fracture of the facial surface of the maxillary sinus and the orbital floor, and the orbital process of the malar was driven into the maxillary sinus.

"2. The blow was applied to the infraorbital ridge with the following result: the frontal process of the malar was broken below the articulation with the frontal; the facial surface of the maxilla was fractured vertically; the zygoma was fractured at its junction with the squamous portion of the temporal and there was a lateral displacement of the zygomatic arch.

"3. Force was applied to the bridge of the nose, with the result that the nose was crushed with a bucking upward of the nasal septum causing a fracture of the cribriform plate and loosening of the crista galli; there was a separation of the frontal process of the maxilla from the nasal process of the frontal, thus opening the floor of the frontal sinus. There was a comminuted fracture of the ethmoid labyrinth and the pterygoid process was broken from the body of the sphenoid, thus opening the sphenoid sinus.

"4. Force was applied to the alveolar process from in front similar to the injury sustained when the victim is thrown against a dash or back of the front seat of an automobile. As a result both maxillae were fractured horizontally through their bodies, thus exposing the maxillary sinuses. The nasal septum was fractured from before, backward through the septal cartilage and vomer."

In analyzing these experiments, one notes that all forces resulted in separation of one or more of the points of attachment aforementioned, with the exception of the force applied to the anterior portion of the maxilla. It is my belief that this force was essentially perpendicular to the plane of attachment, and even though the force was of sufficient magnitude to produce a complete horizontal fracture of both maxillae, still there was no evidence of fracture at any one of the eight points of attachment of the zygo-palatine-maxillary bones.

Naftzger¹⁶ stated that many inaccuracies can be found in the experiments. Nevertheless, they give one a much clearer conception of what takes place when various forces are applied to the bones of the face. They demonstrate that when a force is applied to the middle third of the face, and if applied at right angles to the plane of attachment of the zygo-palatine-maxillary bone, there will result either a horizontal fracture of both maxillae or in many cases no fracture at all.

All surgeons have seen evidence of blows of considerable force on the anterior third of the face with no evidence of fracture. On the other hand, if the direction or force of the blow is such as to cause a separation of any one of these eight points of attachment, the supporting structure collapses, and multiple comminuted fractures occur. One reason there are so many fractures through the anterior wall of the maxilla is that the frontal and temporal attachments of the zygo-palatine-maxillary bone hold and the frontal process of the maxilla and the palatine pterygoid attachments give way.

For correct diagnosis and treatment of fractures of the facial bones there is no substitute for a concise knowledge of the anatomy of the bones involved. Likewise, a knowledge of the dynamics of fractures of the facial bones is of great aid in anticipating the various types of fractures encountered.

DIAGNOSIS

Authors vary greatly in the stress they place upon methods of diagnosis. Some emphasize roentgen diagnosis whereas others believe that roentgenograms should be taken but that they usually prove of little benefit. There are few who would rely on roentgen diagnosis alone. Brown and Fryer¹² stated: "Complete reliance for diagnosis cannot be placed on x-rays alone . . . The heavier ridges of the bone show quite well in the antral and vertico-submental positions, but there may be many comminutions of the maxilla, ethmoid, nasal and other thin bones that are entirely missed on the x-ray plate." Ellis, Windham and Latiolais¹⁷ observed: "We are impressed with the difficulty in interpretation of the films, and find that information gained on inspection and physical examination of the patient is more valuable." Slaughter and Wong¹¹ expressed this opinion: "X-ray examination may be necessary to actually localize the fracture, and it is an indispensable aid in confirming a diagnosis." Blair and Byars¹⁸ concluded: "A good rule to follow is, if a fracture of the middle third of the face is revealed on the x-ray plate, that multiple fracture lines which are not revealed must be present." They added: "Crushing injuries to the face of the antrum may be revealed only as a relative opacity of the antrum." These statements of Blair and Byars and Brown and Fryer¹² sum up, in my opinion, the role of roentgen examination in the diagnosis of fractures of the facial bones.

More, however, can be said in regard to related bone fractures. Brown and Fryer¹² mentioned the importance of roentgenograms of

the skull and also of the cervical spine. Hilger¹⁰ noted: "The British in the Eastern half of Italy, during the Italian campaign, found that 20 per cent of a large series of such cases had suffered a compression fracture of one or more vertebrae." His experience in a smaller series was confirmatory.

In the series of 147 cases reported here, there were five cases of associated fracture of the cervical spine. In the majority of these cases, however, roentgen examination of the cervical spine was not made. I now believe that in all cases of fracture of the facial bones roentgenograms of the cervical spine should be made.

All authors agree that inspection and palpation are necessary in making a diagnosis. Some stress inspection whereas others say that the patients all look the same. Martin¹⁹ quoted Sir A. H. McIndoe as follows: "They are all brothers and sisters, their only difference is in sex." I believe that most surgeons who have had experience with war injuries of the face will agree with this statement; however, in civilian practice one often sees extensive fractures of the facial bones with little edema. In these cases inspection is most helpful in diagnosing fractures of individual bones. Some authors insist that one should wait for the edema to subside in order to make use of inspection. Fortunately, most authors, are totally averse to this delay as much valuable time is wasted.

Because of the superficial location of the bones of the face, palpation of the orbital rims, the zygomatic prominence, the zygomatic arch and the nasal bones, and also intraoral palpation are mentioned. The movement of the maxilla is mentioned, but too few authors stress the danger of moving the maxilla and possibly tearing the dura. I think that one should determine if the maxilla is movable, but to test the degree of mobility is foolhardy.

The diagnostic problem in many cases is a most complicated one. In the majority of cases it entails the best skills of the neurosurgeon, oral surgeon, roentgenologist and otolaryngologist. Someone should be in charge of the general care of the patient, and it has been my experience that the neurosurgeon should fill this role. The problems of shock, hemorrhage and cerebral concussion, any one of which may be paramount, are in the immediate realm of the neurosurgeon. It should be his responsibility to advise the otolaryngologist and the oral surgeon when to start operative therapy.

For the purpose of uniformity and standardization of diagnostic technic, the important diagnostic procedures may be listed as follows:

I. Function

1. General body functions

- (1) State of consciousness at the time of examination and immediately following injury
- (2) Orientation
- (3) Amnesia
- (4) Peripheral reflexes
- (5) Cranial nerves
- (6) Blood pressure
- (7) Temperature
- (8) Pulse
- (9) Respiration

2. Occlusion and trismus

3. Visual acuity

4. Diplopia in any field (red lens test)

5. Movement of the facial muscles, particularly those of the forehead

6. Movement of the neck

7. Rigidity of the neck

II. Deformity and Other Evidences of Fracture

1. Inspection

2. Palpation (depression, crepitation, et cetera)

3. Roentgen study

In the diagnosis of fractures of the facial bones, it cannot be overemphasized that a knowledge of the anatomy and dynamics involved is indispensable. Many times it is at first possible to elicit only one fracture, but a good insight into the dynamics and anatomy enables one to anticipate other fractures and with more careful search localize them.

TREATMENT

Early General Treatment. It is encouraging to find that practically all recent authors stress the importance of the immediate evaluation and the general care of patients with fractures of the facial bones. With hardly an exception, they mention cerebral concus-

sion, shock, hemorrhage and an airway. There is little divergence of opinion that these conditions, if present, should be treated before any attempt is made to reduce the fractures.

When is the ideal time for reducing and immobilizing these fractures? Most all authors now agree that they should be reduced and immobilized as soon after the injury as the patient's general condition permits. Brown and Fryer¹² stated: "The primary repair should be done as soon as the patient's general condition permits, and in the first 24 hours if possible, before swelling, organization of clots and infection have occurred." Blair and Byars¹⁸ concluded: "Thus delay in repair is justified only in the face of mitigating circumstances, such as neurological damage, shock, the presence of a more acute emergency elsewhere in the body, or of a spreading infection which has already set in." There are a few who believe that one should wait until edema of the overlying tissues has subsided. Gill⁸ made the following statement: "Swelling of overlying tissues may occasion delay in reduction for several days because one cannot accurately determine by palpation when reposition has been effected." Erich²⁰ observed: "Haste has no place in surgery of the face." He concluded, however: "Because they are but rarely vital to the life of the patient, wounds of the face are often completely neglected for other injuries of a more serious character. In the majority of cases, such neglect is entirely unwarranted." Slaughter and Wong¹¹ emphasized early treatment with this observation: "Sound clinical judgment is just as necessary here as in any other surgical emergency, because much depends on the speed of making a diagnosis so that the necessary treatment may be quickly instituted."

The fact that a number of authors do not mention the time factor makes it even more important that a policy of early treatment should be instituted in the effort to standardize therapeutic technics in cases in which there is fracture of the facial bones. Otolaryngologists have all seen the neglected cases and have all witnessed the poor results obtained due entirely to the interval between injury and reduction. So many of these cases are cared for by the general surgeon, the orthopedic surgeon and the neurosurgeon that it should be the otolaryngologist's responsibility to impress these colleagues with the great importance of early treatment in cases of this type.

From the standpoint of the otolaryngologist, little need be said regarding repair of soft tissue. Blair⁶ during World War I advocated minimal debridement of facial wounds, and with few exceptions surgeons today adhere to this principle. Thorough cleansing and the removal of tattoo marks are stressed repeatedly. The plac-

ing of close fine silk interrupted sutures is advocated again and again, and yet these wounds are too often closed with widely placed heavy silk sutures placed far from the wound margin. The early removal of sutures in facial wounds is general information, but too frequently they are left in for a week or so. The treatment of wounds of the soft tissues of the face, I believe, has been standardized by America's great plastic surgeons of World War I and II, and the only course left now is to practice and preach these standardized technics.

Anesthesia. The purpose of anesthesia in reduction and fixation of fractures of the facial bones is to provide least discomfort for the patient and to promote as near ideal working conditions for the surgeon as possible. The surgeon cannot do his best work on a patient who complains of every manipulation, particularly when the ultimate result is dependent upon the precision of this manipulation. On the other hand, if the surgeon can induce adequate local anesthesia either by infiltration or block methods, it is foolhardy to insist on general anesthesia. It is also impossible to anticipate what anesthesia will be required in every case. It has been my experience that in some of the most severe cases of fracture of the facial bones only local anesthesia was required. In the series of 1,148 cases reported by Leech, Drum and Osterhagan,⁹ the plastic maxillofacial team found compelling reasons for using a general anesthetic in the majority of cases. These authors explained: "It was impossible to give these patients adequate surgical preparation under local anesthesia, for the wounds were filled with caked sulfanilamide powder, dirt, and dried blood so that it was necessary to scrub the area with white soap and liberal quantities of water and to irrigate the wounds with sterile saline solution." Their usual procedure was to give endotracheal ether with Flagg apparatus. There is certainly no criticism of using general anesthesia in the majority of cases of war injury. Circumstances exist with war injuries, however, which are not so commonly encountered in civilian practice, such as loss of tissue, degree of wound contamination and economy of time. To economize time in treating war-injured often means that more men will receive adequate treatment.

It seems to me that the ideal situation is to start the operative procedure with local anesthesia, but with an anesthetist at hand. Fortunately, physician anesthesiologists are available at the local hospital, and it is my policy to start the operative procedure under local infiltration and block anesthesia, then to resort to general anesthesia if necessary. I consider it impossible for any surgeon to anticipate with accuracy in cases of this type which patients will require general anesthesia. It is certainly foolish to assume that local anesthesia

will be adequate and make no provision for general anesthesia in case the local is inadequate. The choice of anesthetic agent employed to induce general anesthesia should be left entirely to the physician anesthesiologist if one is available, and, if not, I would tend to favor ether. The introduction of curare has certainly diminished the incidence of laryngospasm, which has always been feared in cases of this type when pentothal sodium was used. In a number of the cases of this series pentothal sodium and curare were employed. In the hands of an expert they make an ideal choice. A tracheal tube was inserted in most of the cases of the series; it affords a great safety factor both in insuring an adequate airway and preventing aspiration. In case the tracheal tube is not passed, it is my policy to pack the nasopharynx if a general anesthetic is used.

It is obviously impossible to offer one standard anesthetic for use in all cases of fracture of the facial bones. On the other hand, it is possible to standardize the policy of adequate anesthesia and preparation for a general anesthetic if necessary.

Technics. Is standardization of technics for reduction and immobilization feasible? It is agreed by most authors that there is no panacea of technic or appliance for treating fractures of the facial bones. When one considers all the appliances used by the orthopedic surgeons for the reduction and immobilization of fractures of long bones, there is no wonder that many varied appliances have been devised for immobilization of fractures of the facial bones.

Some authors, however, have become so enthusiastic over certain procedures that they actually have introduced them as panaceas. In referring to internal wiring fixation, Ellis, Windham and Latiolais¹⁷ praised this method in these words: "The outstanding features of this method of treatment are its simplicity, its panacea of application, the comfort it affords the patient, the lack of continuous and/or frequent adjustments necessary. . . ." In spite of their enthusiasm for this most useful method, they later stated that "not all fractures of the facial bones should be treated by this method. I agree entirely with Erich,²⁰ who observed: "However, in surveying the literature, one encounters certain difficulties, the most perplexing of which is the discovery that a great many procedures are described for the correction of the same type of injury. Although such methods are often contradictory in principle, the objective of each is identical. It has been suggested that this lack of uniformity causes many doctors considerable difficulty in selecting the most suitable method or methods of treatment to be employed in any specified case. . . Even assuming that standardization of treatment

would be desirable, the solution to many problems which arise in the primary management of facial wounds still would require of the surgeon an intelligent application of the essential principles of therapy as well as personal initiative and, above all, interest."

Thus there are innumerable methods of reducing and immobilizing fractures of the facial bones, and it is not the purpose of this paper to enumerate every method and every appliance that has been described in the literature. The purpose is rather to cite the fundamental principles of therapy and endeavor to integrate the various technics along lines of proved methods.

First to be considered is the question of open versus closed reduction in cases of fractures of the maxilla. Adams²¹ favored internal wiring fixation of fractures of this bone. He stated: "Since the maxilla is the foundation structure, accurate apposition and immobilization of this fracture is of prime importance. . . . Following wiring fixation of the infraorbital ridge, intra-antral packing with gauze or other substance is unnecessary." Ellis, Windham and Latiolais¹⁷ referred to internal wiring fixation as being an open type of reduction, and yet the fracture is not explored completely. These authors mentioned simple fractures of the maxilla, and I certainly agree that internal wiring fixation is ideal in simple fractures. It has not been my pleasure, however, to see many simple fractures of the maxilla. If one depends on roentgen examination and palpation, he may diagnose many fractures of the maxilla as simple, but if he chooses to explore, he will seldom fail to find extensive comminuted depressed fractures of the anterior and lateral walls of the maxilla. It is inconceivable that one could fix each of the small fragments of this eggshell type of fracture by internal wiring.

Fortunately, the anterior and lateral walls of the maxilla and the body of the zygoma can be explored through an intraoral incision. Some authors state that in making such an incision one is converting a simple into a compound fracture. It is my contention that a fracture involving the maxillary sinus is a compound fracture, and in keeping with well founded orthopedic principles, one is justified in treating it openly. In discussing reduction of fractures of the maxilla, Blair and Byars¹⁸ concluded: "This is best obtained by making a small incision through the mucosa in the upper buccal fornix, entering the antrum through a fracture line, and elevating all misplaced structures. . . . Following this, a long strip of one-inch iodoform gauze is fed into the antrum and packed gently but firmly into all its crevices and contours, molding the face from the outside until all structures, especially the orbital borders and prominence of

the cheek, have been moulded into their proper position." Hilger¹⁹ remarked that "... badly comminuted fracture of the malar bone requires intra-sinus elevation." Referring to fractures of the maxilla, Woodward and Fitts-Hugh²² explained: "In other cases we employ the external Caldwell-Luc approach. . . ."

Discussing fractures of the maxilla and zygoma, Martin¹⁹ stated: "The depressed fracture of the zygoma with its associated fractures of the maxilla are common. Several approaches to this problem have been used. Sir H. D. Gillies has described the temporal approach for elevation of this structure. This procedure is excellent for elevation of the fractured arch but as for elevation of the malar compound is less than useless. There is usually a comminution of the orbital floor with depression, blood and often loose bone fragments in the antrum. Any operation devised for repositioning this bone must consider these factors: (a) to drain this compound fracture, and (b) elevate the orbital floor. One must enter the sinus through the Caldwell-Luc approach. The orbital floor is repositioned under direct vision. The antrum is cleared of debris. Drainage can be provided into the nose and the position of the zygoma maintained with packing." Shea²³ concluded: "If the antral wall is badly depressed, the force exerted to replace the fragments must be intra-antral." There are many more statements similar to these in the literature.

In keeping with the foregoing statements, in my opinion one can say without reservation that any method of treating a fracture of the maxilla which does not involve a Caldwell-Luc approach may be considered inadequate. It is of course fully realized that it may be necessary to use various methods for fixation or traction after the fracture has been explored and reduced. The method used after the fracture has been reduced is of secondary importance.

All authors agree that fractures of the nasal bones should be reduced early and by external and intranasal pressure. Some advocate various intranasal appliances attached to head caps. Most agree, however, that the nasal bones can be held in position by intranasal packing alone. Erich⁷ observed that "no means of fixation other than an intranasal pack or external splint is necessary to maintain the nasal bones in their proper position."

A number of methods have been advocated for the reduction of fractures of the arch of the zygoma. Goldthwaite⁸ elevated the arch by means of a periosteal elevator introduced through a buccal incision. After reducing a fracture of the maxilla, I have employed this method and have found it useful; however, on a number of occasions I have not been satisfied. Roberts⁸ suggested a screw device.

Gillies¹⁹ introduced an elevator into the temporal fossa and elevated. Gill⁸ used a special forceps, similar to a large towel forceps, to grasp the displaced fragment through the skin and move it into position. I have tried the Gillies method and the Gill method, and they both have merits.

While treating cases of this type in the service I came upon a large orthopedic hook which serves perfectly. I introduce it into the temporal fossa above the zygomatic arch and first pass it completely beneath the fragments. I then back up, so to speak, and feel for the fragment with the point of the instrument. When the point of the hook engages the fragment, using the base of the hook as a fulcrum in the temporal fossa, I elevate the fragment.

Gill⁸ noted: "Blair, Bodine and Kazanjian emphasize in their writings that in certain badly comminuted fractures of the upper jaw interdental appliances are oftentimes of great value." In my opinion, interdental wiring in cases of fracture of the alveolar process of the maxilla is mandatory in most cases. Such a fracture is usually associated with malocclusion and is a problem for the oral surgeon. I believe that it should be a standard procedure to have an oral surgeon in consultation in all cases of fractures of the superior alveolar process or mandible. I also believe it should be a standard procedure to have a neurosurgeon in consultation in cases of fracture of the frontal bone.

If one is confronted with an intact mandible in the presence of a fractured maxilla which requires elevation, such as a Guérin's fracture, use should be made of the mandible. The maxilla then will not only be held in its proper position, but normal occlusion will result. This can be done simply by attaching a chin piece to a head cap appliance with rubber bands.

Appliances. This paper would not be complete without making some mention of the many ingenious appliances that have been devised to maintain fixation in the treatment of fractures of the facial bones. The plaster head cap with coat hanger wire incorporated is mentioned many times in the literature. The first reference to it that I could find was made by Straith.⁵ It is an excellent and easily constructed appliance. Gill,⁸ however, commented: "Occasionally one will encounter a patient sufficiently stolid to endure the discomfort of the plaster cap fixation. . . ." This has not been my experience. In case the head cap is uncomfortable, I conclude that it has not been properly padded and I immediately make another. Recently, I have been using castex in place of plaster for the head caps, as in the case herein reported. It is much lighter than

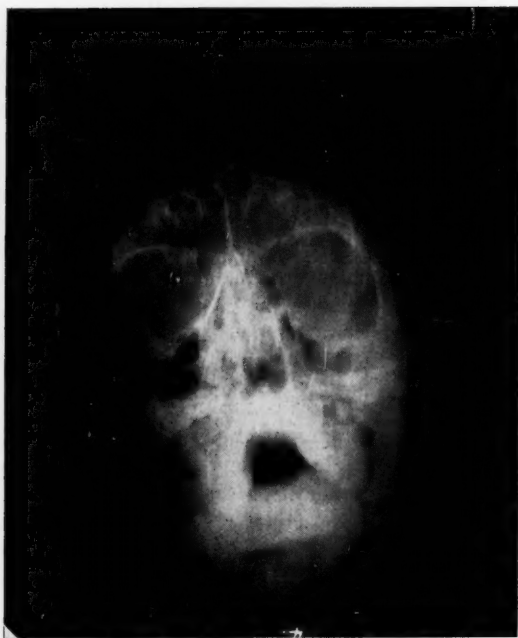


Fig. 1.—Waters position showing separation of the left zygomatico-frontal suture with depression of the left inferior orbital rim. Cloudy left maxillary sinus and complete transverse fracture of the superior alveolar processes. Displacement and rotation of the maxillas are shown by change of position in relation to the mandible and orbits. The left zygomatic arch is fractured.

plaster. A solution comes in a separate bottle with the rolls, and I find it is necessary to use the solution liberally. These creations are not always the most becoming, but they serve the purpose and should be just as comfortable and effective as the specially constructed caps which one can purchase.

Something should be said in regard to the rubber band traction which is also used by many. Bellinger impressed me a number of years ago with the fact that little traction is required. I believe that it is a common error to put on too much tension and thereby produce overcorrection and add to the patient's discomfort. Also, it is not necessary for the patients to wear the cap constantly. I insist that they wear it at night, for it is during the sleeping hours that the most will be accomplished.



Fig. 2.—Slightly oblique view showing complete transverse fracture of the superior alveolar processes. No evidence of fracture of the cervical vertebrae.

One of the most recent appliances introduced for the fixation of fractures of the facial bones is Kirschner wire. Blair and Byars¹⁸ stated: "Recent methods which are very useful . . . are the transfixation of the fracture line with bicycle spokes or Kirschner wires as a closed procedure, as recently mentioned by Brown. . . ." I have made use of Kirschner wire and find it ideal in certain cases. My associates and I have all been dissatisfied with reduction of fractures of the nasal septum. In one case in which two Kirschner wires were used to transfix a bilateral fracture of the maxilla, it was possible to hold the septum in perfect position. We have also made use of Kirschner wires to immobilize a Le Fort type I or Guérin's fracture with complete detachment of the superior alveolar process. Our oral surgeon collaborated in this case, as he has in all of my cases involving fractures of the superior alveolar process and the mandible. A report of this case follows.

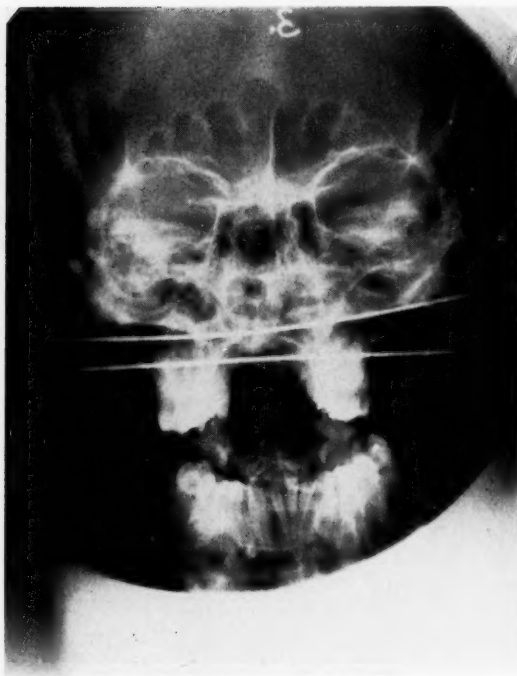


Fig. 3.—Anteroposterior view showing the two Kirschner wires in place supporting the superior alveolar processes.

REPORT OF CASE

R. C. P., aged 34, an airplane crop duster, was hospitalized on May 30, 1950, following a collision in which his airplane collided head on with another airplane as he was taking off. After receiving treatment at a local hospital for shock and lacerations of the face, he was removed to our hospital for definitive treatment. His chief complaints were pain in the upper jaw and face, complete nasal obstruction, moderate difficulty in breathing, inability to see with the left eye and a feeling that all the upper teeth were loose.

Aside from a tonsillectomy six years previously, there was no history of illness, and the family history was irrelevant.

Physical examination revealed a well developed, well nourished, young white man in acute distress. The blood pressure was 116 systolic and 80 diastolic. The pulse rate and respirations were normal, and the temperature was 99 F.

On ocular examination the conjunctivas were ecchymotic. Otherwise, the right eye was normal. In the left eye, there was no light perception; the pupil was dilated and irregular and did not react to light; the media was hazy, owing to large vitreous opacities. The optic disk and the retina were partially obscured by massive subhyaloid hemorrhage. Ocular movements were normal.



Fig. 4.—Photograph showing the anterior Kirschner wire presenting in the roof of the mouth. The posterior wire presented in the floor of the nose.

Aural examination gave negative results.

The entire face was markedly edematous and ecchymotic. There were several small sutured lacerations of the face and lower lip. On the left side, depression of the inferior orbital rim and the zygomatic arch was noted, and also crepitation on palpation of the nasal bones, maxilla and zygoma.

The upper incisor teeth were broken off and missing, and the oral mucous membrane of the entire superior alveolar process was lacerated. Palpation disclosed a complete separation of the superior alveolar process, which apparently was attached only by the soft palate.

Neurologic examination indicated that the patient was well oriented, and there was no history of unconsciousness. The slurred speech was attributed to facial injuries. With the exception of the left optic nerve, all cranial nerves were normal. The remainder of the physical examination and the usual laboratory tests were noncontributory.

Roentgenologically, there was demonstrated an extensive comminuted fracture of the maxilla which had resulted in complete separation of the hard palate and teeth from the adjacent facial bones. On the left side, there was downward displacement of the superior portion of the maxilla, and the fracture lines were demonstrated on the outer rim and floor of the orbit. Not so well demonstrated was a probable fracture of the floor of the right orbit, which was not depressed. There were also multiple fractures of the nasal bones. In the lateral view of the mandible on the left side, a small bone fragment adjacent to the anterior surface of the upper cervical vertebrae apparently represented some anatomic structure, such as one of the vertical foramen, rather than a fracture fragment (Figs. 1 and 2). Slight radiopaque density was superimposed on the superior portion of the left optic foramen.

At operation on May 31, under 1 per cent novocain anesthesia a small incision was made in the right cheek immediately below and anterior to the zygoma. After introduction of two bite blocks, which brought the alveolar process into good position, a Kirschner wire was introduced through the maxilla, engaging the hard palate and presenting in the roof of the mouth (Fig. 4). This wire was



Fig. 5 (left)—Photograph of the patient showing Kirschner wires attached to the castex head cap with rubber bands. Exotropia, due to complete loss of vision of the left eye, is present. (right)—Patient 18 months following treatment.

then drilled through the maxilla on the left side and brought out beneath and anterior to the zygoma. Approximately 3 cm posterior to this wire, a second wire, similarly introduced, engaged the hard palate and presented in the floor of the nose, coming out on the left horizontally with the first wire (Fig. 3). The ends of each wire were bent so that rubber bands could be incorporated and attached to a previously prepared castex head cap appliance (Fig. 5). The comminuted fractures of the maxilla, zygoma and nasal bones were elevated. The nose was packed with vaseline gauze. The wire appliances were attached to the head cap appliance by means of rubber bands.

Medication consisted of floccillin, 300,000 units every six hours, 1,500 units of tetanus gas gangrene antitoxin, 10 cc of a 10 per cent solution of calcium gluconate intravenously daily, $1/3$ grain of pantopon every four hours as needed, 10 mg of synkayvite daily, an alkaline antiseptic mouth wash three times a day, paredrine and sulfathiazole, 4 drops in each nostril three times a day, and ice compresses to the face continuously.

The patient was discharged from the hospital on June 14. Following an uneventful recovery, the Kirschner wires were removed on July 14.

Preserved cartilage and bone are commonly used for filling defects. Bellinger²⁴ directed attention to the use of tantalum in maxillofacial and oral surgery.

In the field of reconstructive surgery of the face, there are many more appliances and materials, too numerous to mention here. It is the responsibility of the surgeon performing this type of surgery to be informed regarding the many useful appliances and materials available for the fixation of fractures of the facial bones. It is of course unthinkable to consider standardizing these appliances and

materials. One should always keep in mind the purpose of a particular appliance or material, and as long as it serves that purpose and does not add to the patient's discomfort, it is adequate.

SUMMARY AND CONCLUSIONS

There is a definite need for standardization of the diagnosis and treatment of fractures of the facial bones.

The literature is filled with descriptions of individual methods and appliances for reducing and immobilizing fractures of these bones.

During the twentieth century there has been a definite increase in the incidence of fractures of this type.

The incidence of fractures of individual bones varies considerably in series reported by civilian physicians, but is uniform in series reported in World Wars I and II.

Authors differ as to what bones constitute the facial bones. A classification is suggested.

It would be desirable to discard the term malar bone and refer to this bone only as the zygoma.

The maxilla, palatine bone and zygoma are so firmly attached at their suture lines that in the study of fractures they may be considered as one bone, namely, the zygo-palatine-maxillary bone.

Complete reliance for diagnosis of fractures of the facial bones cannot be placed on roentgen studies alone.

For correct diagnosis and treatment of fractures of the facial bones there is no substitute for a concise knowledge of the anatomy of the bones involved. A knowledge of the dynamics of fractures of these bones is of great aid in anticipating the various types of fractures encountered. With a view to standardization of diagnostic technic, the important diagnostic procedures are outlined.

Most authors agree that these fractures should be reduced and immobilized as soon after the injury as the patient's general condition permits.

Certain fundamental principles of the treatment of fractures of the facial bones which can be standardized are discussed. A policy of adequate anesthesia and preparation for a general anesthetic, if necessary, is suggested. The Caldwell-Luc approach in any method of reducing fractures of the maxilla is considered practically mandatory. The value of interdental appliances in appropriate cases is mentioned. Consultation with an oral surgeon in all cases of fracture

of the superior alveolar process or mandible and with a neurosurgeon in cases of fracture of the frontal bone is advised.

The surgeon today has available many appliances and materials to aid him in treatment of fractures of the facial bones. Among those mentioned here is castex as a substitute for plaster in the making of head caps. A large orthopedic hook is suggested for use in reducing fractures of the arch of the zygoma. Comment is made upon the use of Kirschner wire, and an illustrative case is described.

A series of 147 cases of fractures of the facial bones, in which treatment was rendered between 1946 and 1950, is reported.

NOTE: Dr. Robert G. Neill, neuro-surgeon, and Dr. Wilbur McL Davis, oral-surgeon, were associated with the author in the care of the reported case.

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AN ANALYSIS OF 240 CASES OF CANCER OF THE
LARYNX, WITH RESPECT TO THE TERMINAL
PHASES AND DEATH

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The question has often been asked, "Of what do patients who have cancer of the larynx die?" What ultimately kills these patients? What is the terminal phase of a patient who has an uncontrolled cancer of the larynx? I was unable to find in the literature, a statistical report on the cause of death of patients with cancer of the larynx. Most death certificates and final reports and summaries give "Cancer of the Larynx" as the cause of death. Yet cancer of the larynx per se could not have been the terminal or actual cause of death, providing there was a clear airway.

In an effort to find the answer to these questions, a survey of cases of cancer of the larynx for the past ten years was made.

The purpose of this paper is to attempt to determine the actual terminal phases of patients with cancer of the larynx.

These cases include all patients on whom a positive diagnosis of cancer of the larynx was made by biopsy. It was impossible from the records reviewed to classify these lesions as to whether they were intrinsic or extrinsic in origin. They were included in this series if the primary lesion involved the larynx.

A total of 240 patients was studied and for the purpose of this report was classified into three groups. Group 1 includes those patients who died and upon whom necropsy records are available. Group 2 includes those patients who died, but upon whom no necropsies were performed. Group 3 includes those patients who are alive at this writing, but some who are approaching the terminal phases.

Of the 240 cases reviewed, 117 cases or 48% are dead at this writing. Of the 117 cases that died, 38 cases or 33% came to necropsy. The necropsy findings in the 33% group are listed in Table 1.

Presented as a candidate's thesis to the Am. L. R. & O. Society.

TABLE 1.

NECROPSY FINDINGS IN 38 CASES:		METASTASIS TO:	
NO. OF CASES		NO. OF CASES	
26	Cachexia	27	Cervical nodes
8	Hemorrhage local	8	Hilar nodes
24	Bronchopneumonia	1	Heart
1	Pulmonary artery thrombosis	8	Lungs
		3	Liver
1	Toxic myocarditis	1	Bones
2	Cloudy swelling of kidneys	1	Spleen
		1	Adrenals
6	Lung abscess	3	Kidneys
4	Pulmonary T.B.	2	Esophagus
1	Brain damage from carotid ligation and radical neck dissection	1	Jejunum
		1	Mesenteric nodes
2	Hypoproteinemia	4	Thyroid
2	Tracheo-esoph. fistula	1	Submaxillary gland

GROUP 1. (Necropsy Cases). We note in this table that eight patients (21%) died as a result of hemorrhage. In six cases the hemorrhage occurred from an ulcerating lesion within the larynx or from an ulcerating lesion about the tracheostomy opening. The pathological reports did not specify the vessel branch that was eroded. One patient died from massive hemorrhage from the right common carotid artery and one was reported as dying from massive hemorrhage from the left internal jugular vein. Whether or not a thrombus was present was not reported. Twenty-four patients died of terminal bronchopneumonia. One death was reported due to pulmonary artery thrombosis and one patient died of toxic myocarditis. Two patients died of pulmonary tuberculosis with extensive cavitations. Bilateral pulmonary abscesses was given as the cause of death in one instance and this in a patient with tracheo-esophageal fistula. One patient died of extensive brain damage following carotid ligation.

tion and extensive neck dissection. We note that only two patients were reported as showing evidence of hypoproteinemia.

Cachexia was reported in 26 cases.

Metastasis to the cervical lymph nodes was reported by the pathologist in 27 cases and metastases to the hilar lymph nodes in eight cases of the remaining 11. It is probable that even though the pathologist did not report it, there was also involvement of the cervical lymph nodes in these eight cases.

Asphyxia due to laryngeal obstruction did not contribute to the cause of death in any of these patients. Eighteen of the 38 patients had tracheotomies performed on them, either as emergencies or early to prevent and avoid asphyxia. Five had laryngectomies performed. Fifteen evidently maintained an airway in spite of a laryngeal lesion and neck metastases.

Of these 38 patients, 25 were treated only by radiation and 15 of these 25 had tracheotomies. Two patients had laryngectomies done for the primary lesion and radiation to the metastatic lesions. Eleven received no definitive treatment, other than terminal care. Hemorrhage was not reported in the laryngectomized group.

GROUP 2. In the second group, that is, those patients who died, but upon whom no necropsies were performed, the information given in Table 2 was gathered from death records, final summaries and personal observations.

In this group of 79 patients the cause of death was given as bronchopneumonia in 49 of them. Thirteen (16%) died of hemorrhage. The hemorrhages were from ulcerating lesions of the larynx in four instances; from ulcerating lesions around the tracheotomy wound in eight and from massive hemorrhage from the right external carotid artery in one. One patient died of coronary heart disease. One died following a frontal lobotomy in an attempt to control intractable pain. In four patients pulmonary tuberculosis with cavitation was given as the cause of death.

It is significant that patients with advanced carcinoma of the larynx are also not uncommonly the victims of tuberculosis. The belief has been expressed that a cause and effect relationship between laryngeal cancer and pulmonary tuberculosis may exist.¹

There were two cases of lung abscesses in two patients with tracheo-esophageal fistulas. One patient died from shock while undergoing a tracheotomy and one was an anesthesia death while being prepared for laryngectomy. Five deaths had to be listed as "cause

TABLE 2.

PATIENTS DIED—NO NECROPSIES (79)		METASTASIS TO:	
NO. OF CASES		NO. OF CASES	
47	Cachexia	29	Cervical nodes
13	Hemorrhage		
6	Anemia	1	Spinal cord
49	Bronchopneumonia	1	Pancreas
2	Lung abscess	1	Bone
4	Pulmonary T.B.		
2	Tracheo-esoph. fistula	6	Lungs
1	Hypertension and cor- onary heart disease	2	Skin
1	Toxic degeneration, spleen and kidneys	1	Brain

of death unknown," because the patients died outside the hospital and on followup the exact cause of death was unobtainable.

Two cases presented interesting features. H. B., white male, aged 56, had a laryngectomy performed for carcinoma of the larynx, squamous cell, grade 2, in 1939. In 1949, ten years later, he died with a diagnosis of adenocarcinoma of the rectum with widespread metastasis to the abdominal cavity and both lungs. Having survived one carcinoma, he succumbed to a second and different type carcinoma. The second case was that of L. C., a white male, aged 58, who in 1947 had a laryngectomy performed for carcinoma of the larynx and in 1949, two years later, was readmitted for carcinoma of the tongue with metastasis to the cervical nodes and to both lungs. One might speculate as to whether these were two separate and independent lesions or whether the latter was a recurrence of the former. This patient was admitted as a terminal case and died shortly after admission.

Cachexia was noted 47 times in this group.

Metastasis to the cervical lymph nodes was reported in 59 patients. Metastasis to the lungs was noted in six. An x-ray diag-

nosis was made in one instance, of metastasis to the spinal cord, and in another to the long bones (femur). A clinical diagnosis was made of metastasis to the pancreas in one patient and metastasis to the brain in another.⁵

In this second group 33 patients had early or emergency tracheotomies performed. Ten others had laryngectomies. The remaining 33 evidently maintained an adequate airway. No causes of death due to asphyxia because of laryngeal obstruction were reported.

In this second group 36 patients were treated by radiation; ten were treated by laryngectomies for the removal of the primary growth and radiation therapy to the metastatic growth. Five of these ten patients died of massive hemorrhage from necrotic ulcerating areas in the metastatic neck nodes. Thirty-three patients had no definitive local treatment.

The laboratory work charted on these cases was reviewed and one finds that only routine blood counts and urine examinations were done. Often anemia is reported as being associated with these cases, but excepting those patients who died of hemorrhage, no marked anemia is noted. The red blood cells averaged 3,400,000 and the hemoglobins about 11 gms. The white blood cells varied between 8,000 and 12,000, the higher figure being found in cases with a pneumonic process or break down and infection of the diseased areas. There was no significant change noted in the differential counts. The urine examinations showed no pathological changes. The specific gravities averaged 1005 and albumen was negative in practically all cases.

GROUP 3 (123 or 52% of the original 240 cases). Of the patients discharged from the hospitals, there are at the time of this writing, 52 who are free of cancer, but five years have not yet elapsed. There are ten persons who are free of cancer and are over the five year period. Of these, six are laryngectomy patients and four are radiation therapy patients. There was no followup on 41 patients.

There are 20 patients who are not free of cancer, that is, patients who have not had the primary lesion controlled or who have developed metastatic lesions at this time.

As one follows these cases of carcinoma of the larynx with an uncontrolled lesion, one notes that as the lesion invades the larynx and the neck nodes become larger or in the laryngectomized patient as the metastatic neck nodes become increased in size, there is noted no rapid change in the general health of the patient. As long as they are able to eat and maintain a sustaining diet, and as long as their

sleep and rest are not interfered with, there is noted no cachexia, no marked anemia and no debility. Clinically, at these stages there is no evidence that toxic carcinomatous products are poisoning the patient or that the growing tumors are sapping or taking nourishment from the host. The relative size of these tumor masses to the body weight of the host is small. Clearly the nutritive demands of such growths can be but small. It has been suggested that it is not the mere bulk in growth of a tumor that matters, but tumors may have special nutritive requirements and may deprive the body of unduly large amounts of such essential factors as vitamins, special amino acids or the scantier mineral constituents of our diet. Yet these patients show no evidence of avitaminosis, negative nitrogen balance⁶ or hypoproteinemia.

It has been shown that the patients who have cancer can establish and maintain a positive nitrogen balance. Even though a malignant neoplasm is growing progressively or a caloric deficit exists, nitrogen can be stored.

A general downhill course usually starts with (a) difficulty in swallowing and resulting lowered intake of food (b) onset of pain and its resulting loss of sleep and mental depression which in turn interferes with appetite and digestion (c) onset of bleeding, which if severe results in exsanguination or if of milder nature, but persistent and recurrent, results in anemia, inanition, mental depression, debility and a realization on the part of the patient that he is "going downhill."

As the lesion progresses and difficulty in taking adequate nourishment increases, our patients are tube fed. They receive 1000 calories in liquid diet and in addition Essenamaine Rum Eggnog and Essenamaine Chocolate Milk, which provide an additional 1255 calories and a total of 120 to 140 gms of proteins.

It is apparent that as long as tube feeding is maintained at an adequate level and the patient has minimal pain, his weight remains at a definite level and he remains in a good state of nutrition. Some of our patients who have signed themselves out against medical advice, have been readmitted with loss of weight, anemia, and in a state of dehydration. On readmission they are given adequate diets, fluid replacement and blood replacement. These patients definitely improve in a comparatively short time, take interest again, become more alert and some are readied for further surgery.

This suggests that though the carcinoma is present and progressive, it is still possible to improve the patient's condition by supplying these nutritional necessities.

However, as the disease progresses, tube feeding becomes limited, opiates must be used for pain and discomfort and secretions begin to pool up in the laryngo-pharynx. In the non-laryngectomized patient the laryngeal lesion becomes ulcerative, necrotic and foul smelling. Because of the inability to swallow, 1500 to 2000 cc of saliva and inflammatory secretions, food and vomitus may accumulate in the airway.² Cough and expulsive mechanisms are ineffective. There may be anesthesia of the larynx probably due to involvement of the superior laryngeal nerve and the glottis becomes a portal of entrance for the accumulated secretions and vomitus. As a result of this, the airflow is mechanically impeded. Considerable accumulations of secretion in the pharynx, trachea and bronchi are found along with symptoms of anoxia. The bechic mechanism cannot clear these secretions and a resulting blockage of the bronchioles and damage to the respiratory area of the lungs occurs. This secretional obstruction goes on to congestion stasis, edema, transudation, increased pulmonary negative pressure, exudation, plugging and pneumonitis. The resulting anoxia and the increased carbon dioxide produce disorientation, irrationality, lethargy, coma and death.

The laryngectomized patient does not have the severe dysphagia of the non-laryngectomized patient and is spared the foul smelling ulcerating lesion of the larynx. Neck nodes appeared in from three to 12 months in these patients. Pain is usually their first complaint and its persistence results in mental depression, loss of sleep, loss of appetite and anxiety. The metastatic lesions break down and form fungating, foul smelling, ulcerating lesions. The metastasis may spread down to the mediastinal nodes causing compression and invasion of the trachea. The necrotic lesions form fistulas and these drain into the trachea and tracheo-bronchial tree. The patient finds it impossible to maintain an adequate caloric intake, the severe pain becomes more and more difficult to control, necessitating larger and more frequent doses of opiates. Inanition, general debility and sleeplessness develop, resulting in weakened and lessened cough reflex and this in turn results in more accumulation of secretions in the tracheo-bronchial tree with obstruction, which goes on to anoxia and resulting death.³

Cachexia was noted 26 times among the patients in Group 1 and 47 times among the patients in Group 2. Of the patients now under observation (15) cachexia and emaciation were noted to appear as the patients were unable to maintain an adequate caloric and nutritive intake. As pain, sleeplessness, anxiety and mental depression interfered with appetite and digestion, a general loss of weight

and debility was noted. The cachexia seems to be progressive in proportion to the amount of pain and to the inadequacy of nutritional requirements. It has been thought that malignant cachexia is a peculiar specific result of the growth of a malignant neoplasm in the body that may be due to poisons or toxins elaborated by the growth or to its parasitic utilization of food substances to the detriment of normal tissues. However, R. A. Willis rejects these views because "(1) no toxic products of tumor growth capable of causing cachexia have been identified (2) the nutritive requirements of tumors are rarely so great as to be a significant contributing factor in undermining health and producing cachexia (3) the presence or absence of cachexia in cases of malignant disease is clearly referable to the presence or absence of obvious enough harmful effects of the growths on bodily function."⁴

The 15 cases now available for observation seem to support this view and the cachexia can be readily accounted for by such debilitating factors as starvation, dehydration, hemorrhage, ulceration, bacterial infection, pain, sleeplessness and anxiety.

The management of patients with recurrent metastatic malignancy of the larynx often requires long range planning. Because of the poor prognosis, general supportive measures are often overlooked and the patients endure a more severe and uncomfortable terminal stage. Every attempt for the control of the disease, whether by surgery or radiation, should be made as early as possible. Today, malignant lesions and their metastases which a few years ago were considered inoperable are being removed surgically. Continued adequate nutrition including essential minerals and vitamins is necessary for patients with metastatic malignancy. Frequent small feedings are preferable to three larger feedings. The administration of blood for blood loss, saline infusions for replacement of electrolytes and to combat dehydration and potassium replacements where indicated go a long way to keep these terminal patients in better emotional state with less anxiety and concern. A patient who can be kept ambulatory and occupied requires very much less nursing care. Keeping patients with metastatic disease free of pain is a major problem. However, the patient who is in better nutritional state, the patient who feels that something is being done for him, the patient who can be kept occupied with some useful project is more tolerant of his pain and requires less sedation. Minimal effective dosages of opiates should be used. It is usually best to use opiates at night to assure rest and sleep.

SUMMARY

A review of 240 cases of cancer of the larynx was made in an attempt to determine the terminal phases and mode of death of the patients. The following conclusions are arrived at:

(1) The cause of death and terminal phases of these patients does not differ in major respects from the terminal phases of the patients who have cancer with metastases elsewhere in the body. Because of a growth primarily involving the upper airway, one might conclude that laryngeal occlusion would be a usual cause of death, but this does not occur when tracheotomy is readily available.

(2) Hemorrhage as the cause of death occurred in only 16% of our patients which is not as high as one might expect from a cancerous growth or metastatic growth, which can produce so much destruction of tissue and ulceration of such vascular areas as the larynx, the root of the tongue and the neck.

(3) Of the cases noted, the laryngectomized patients were spared the foul smelling, painful, ulcerating, necrotic larynx so often seen in patients who were treated with radiation which failed. However, once neck metastases occur and become progressive in a laryngectomized patient, the subsequent course of the disease leads to a condition very little different than in the non-operated case. If the secondary neck metastasis has received radiation that failed, I believe the terminal phase is more severe than if not radiated at all.

(4) The bronchopneumonia so often reported, is a process secondary to blocking of the tracheo-bronchial tree by accumulated secretions, vomitus or blood. These patients show no terminal rise in temperature as is seen in a primary infection. These patients apparently drown in their own secretions.

(5) Only two patients out of 116 died a cardiac death. Carcinoma of the larynx is a disease seen predominantly in the fifth and sixth decades of life. Yet cardiac disease or coronary disease does not contribute significantly to the mortality rate.

(6) Metastases can and do occur to distant organs and tissues, but not frequently. Involvement of such vital organs as heart, spleen, liver and kidneys are infrequent and therefore the patients do not often show evidence of dysfunction of these organs.

(7) The uncontrolled cases of cancer of the larynx become, to a great extent, a nursing problem. Conscientious scientific nursing care is a most important requisite.

(8) Malignant cachexia as an entity produced by toxins or poisons produced by a growing tumor, is not borne out by our observations. It appears as nutrition fails, as pain and sleeplessness and anxiety appear. It is well known that cachexia appears in the terminal phases of other diseases, which are not carcinoma or neoplastic.

Knowing something of the final stages of cancer of the larynx, the kind of downhill pattern of these patients and their mode of death, one is better able and better prepared to carry out a plan of treatment, which will make the last days of these patients less agonizing and more bearable.

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New Instruments

XXII

A CURVED CHISEL FOR USE IN NASAL SURGERY

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The bridge of the nose represents a meeting point of bone and cartilage which are quite different in their responses to surgery, and in the requirements of operative technique.

One of the most common requests for corrective surgery of the nose is concerned with the nasal hump, which represents this cartilaginous-bony junction. The cartilage can be cut with a suitable knife without difficulty. Removal of bone in this region is a particularly delicate operation, since it must be carried out largely by touch, and done without injury to the surrounding soft tissues.

The removal of a nasal hump is not a simple, single procedure, but requires a number of steps, each one of which represents a separate operation in itself. Although one may see in an occasional present-day text-book directions for operating through the overlying skin, the method of choice is carried out by intranasal incision. Through this primary incision, the succeeding steps are followed through; the first is the excision of the hump, after the elevation of the skin, perichondrium and periosteum, taking care that none of these parts is injured.

Removal of the hump leaves an undesirably broad bridge, which is narrowed by fracturing or sawing through the anterior processes of the maxillary bones and pressing their upper borders toward the midline.

One of the particular difficulties in the removal of the excess of bone is in detaching the excised fragment smoothly. It sometimes happens that rough projections of the bony edge are left behind, which must be smoothed down to prevent a lack of satisfactory wound healing, or a persistent nasal deformity. Removing

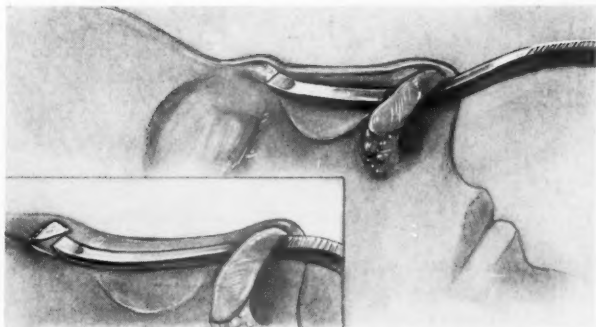


Fig. 1.

such bony projections is a process that requires special skill, since it must be done entirely by touch.

To aid in the removal of such projecting edges of bone, the writer has devised a curved chisel, which has proved more effective and safer than the straight model, because of its easy adjustment to the natural curve of the field of operation, and of less danger of injury to the surrounding tissue.

This curved chisel is made of a slender rod of chrome-plated steel, $6\frac{1}{2}$ inches long, with a cutting edge $\frac{1}{4}$ inch in width. The handle is $\frac{1}{4}$ inch square, and finely ribbed to give grip and purchase in using the instrument. The outline of the chisel is a flattened-S, shaped to follow the line of the nasal cavity (Fig. 1).

After the projecting bony edge has been smoothed down, the operation for removal of the hump is completed by making the required shortening of the septal cartilage, and correcting the form of the tip, if this is required to secure a suitable contour.

2104 SPRUCE ST.

SIMPLIFIED BRONCHOSCOPES

ERNEST B. EMERSON, JR., M.D.

ROCHESTER, N. Y.

To the endoscopist, no matter how long or well established he may be, there arises on occasion the problem of performing bronchoscopy elsewhere than in his own hospital. Patients to whom transportation to the larger centers would actually be deleterious must be bronchoscoped wherever they may be. Often times this presents the problem of transporting a considerable amount of equipment, and, upon arrival, the performing of the necessary instrumentation with help who may have had little or no previous experience in the handling of the highly complicated set up thought to be routine in the larger hospitals.

In the course of 12 years' experience with such circumstances it has become more and more apparent that simplification of armamentarium will result in simplification of procedure. The greatest single step in this direction was made with the introduction of an emergency aspirating bronchoscope containing its own power supply incorporated in the handle along with an attachment for oxygen to go directly into the bronchoscope when necessary.¹ The success of this bronchoscope under trying circumstances indicated that the development of similar bronchoscopes satisfactory for diagnostic and operative procedures would be a blessing to those who must on occasion do this work.

As in the previously described bronchoscope, the present instruments are designed with a dependent handle after Israel,² thereby eliminating not only battery and cords, but also the laryngoscope. Thus the operator needs only to transport the bronchoscope needed, the suction pump and whatever forceps are needed. With the operating equipment thus simplified the endoscopist is almost in a position to work alone. This technique has been previously described by the author.¹

From the Department of Surgery, Division of Otolaryngology, University of Rochester School of Medicine and Dentistry, Rochester, New York, and in conjunction with the Bronchoscopy Service of the Batavia Veterans Hospital, Batavia, New York.

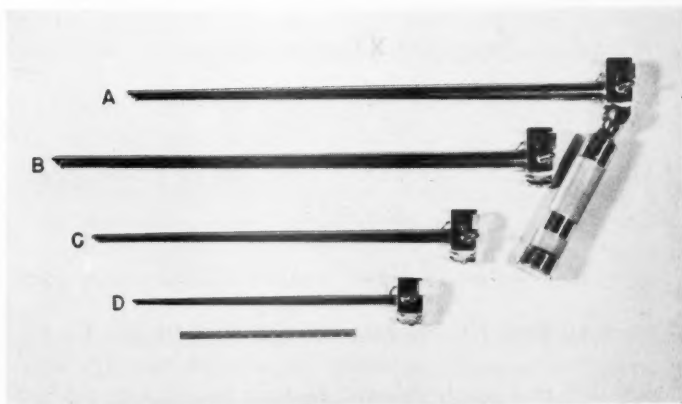


Fig. 1.—Diagnostic Bronchoscopes. A. 7 mm Adult. B. 9 mm Adult. C. 5 mm Child. D. 3 mm Infant. A. has battery handle attached.

The bronchoscopes have been designed in a set of four which should fill the requirements most commonly encountered: a 9, 7, 5 and 3 mm size at the forward end (Fig. 1). The tubes are tapered to increase visibility and ease of instrumentation as first suggested by Negus.³ The 7 and 9 mm instruments have been made 40.5 cm in length; the 5 mm, 30.5 cm; and the 3 mm, 23 cm in length. This is an increase of 6 cm in length, in the adult instruments, over the original emergency bronchoscope which allows ample length for exploration of the lower bronchi.

The battery handles are available in sizes to accomodate flash light batteries from pencil size to standard. Only one handle is necessary as it is interchangeable.

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Society Proceedings

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Meeting of Monday, April 2, 1951

THE PRESIDENT, DR. SHERMAN L. SHAPIRO, IN THE CHAIR

The Adult and His Hearing Problem

FRANCIS L. LEDERER, M.D.

AND

RICHARD E. MARCUS, M.D.

(This paper appears in full on page 126.)

Management of Laryngeal Carcinoma

ALBERT H. ANDREWS, M.D.

AND

WILLIAM KUCERA, M.D.

(Abstract)

During a three year period 71 cases (67 male and four female) of laryngeal carcinoma proven by biopsy have been observed. The methods of curative treatment used and the results are presented. The principles governing selection of treatment were as follows:

Laryngofissure: Small, early, squamous cell carcinoma limited to one vocal cord, without involvement of the anterior commissure or the tip of the vocal process; normal cricoarytenoid motility and movable vocal cord are considered the important criteria.

Laryngectomy: Carcinoma involving areas of the larynx other than the vocal cord, involving more than one vocal cord; cricoarytenoid fixation or vocal cord fixation are the important criteria.

Laryngectomy plus radical neck dissection: Same criteria as above, plus involvement of the cervical lymph nodes.

Radiation therapy: Carcinoma extending out of the larynx into the pharynx, trachea beyond the point of reasonable resection, or into the soft tissues around the larynx; when surgery was refused or when contraindicated because of the patient's general condition.

Intralaryngeal removal (not performed): Small squamous cell carcinoma limited to such a size that it may be removed in one piece by forceps, and with normal cordal and cricoarytenoid motility.

Hemilaryngectomy (not performed): Squamous cell carcinoma of one vocal cord not involving the anterior commissure, minimal extension into the ventricle, or with extension onto the vocal process of the arytenoid are the important criteria.

The conventional technics were used in this surgery, with certain modifications in some procedures. Inasmuch as the survey covers a period of three years, results as to cure cannot be presented adequately. There have been recurrences in seven patients, and 23 patients have died as a result of the carcinoma, recurrence, or conditions secondary to recurrence. At present there is no evidence of disease in 34 patients.

Following laryngofissure, the voice in all instances has been reasonably good. Two patients developed excellent voices and it is difficult to recognize any abnormality in ordinary conversation. The development of bucco-esophageal voice after laryngectomy has been variable. In charity patients the results have been generally poor. In private patients the contrary is true. The co-operation between the broncho-esophagology and the speech and hearing services indicates need for more thorough study of postoperative speech, and more careful evaluation of the surgical technic in terms of the bucco-esophageal voice. The single most important factor appears to be motivation of the patient.

Meeting of Monday, November 5, 1951

THE PRESIDENT, DR. ARTHUR H. COOMBS, IN THE CHAIR

**The Joint Responsibility of the Internist and the Otolaryngologist
in the Removal of Focal Infection**

PAUL S. RHOADS, M.D. (By Invitation)

(Abstract)

An attempt is made to show that in spite of newer methods of treatment of nose and throat infections, a certain proportion of them progress to a localized chronic infectious focus, which is responsible in part, at least, for such systemic conditions as rheumatic fever, rheumatoid arthritis, iritis, bronchiectasis and acute and subacute nephritis. Vigorous administration of antibiotics in the acute stage and even in the subacute or chronic stage will greatly diminish the number and severity of such foci of infection. Recognition of the allergic nature of many of the chronic pathologic processes in the nose and throat will lead to methods of treatment that may make surgical interference unnecessary. When such foci exist, however, in spite of a combined antibacterial and antiallergic attack, they often must be removed surgically under the protection of administration of penicillin, aureomycin or terramycin.

Prevention of these foci by not permitting infections to become chronic and removal of them if they do develop is the joint responsibility of internist and otolaryngologist.

DISCUSSION

DR. WALTER H. THEOBALD: The late Dr. Frank Billings was the pioneer in bacteriology for focal infection. A period of wholesale tonsillectomies and sinus surgery followed. After him came Dr. Ernest Rosenow. Focal infection was so highly specialized at that time that a patient who had torticollis on the right side promptly had a throat culture taken. This was injected into a rabbit which developed torticollis to the right, so Dr. Rosenow named this organism *B. torticollis dextra*. A second patient had torticollis to the left, and when the procedure was repeated the rabbit developed torticollis to the left. This organism was named *B. torticollis sinistra*. Later Dr. Rosenow used organisms that pertained to particular seasons of the year. Vaccines for the fall contained influenza, streptococcus and pneumococcus; when spring came the entire flora was

changed to the organisms most prevalent in that season. The pendulum has now swung back to conservation.

It is a debatable question whether the internist or the otolaryngologist is the better judge as to a focus located in the nose or sinuses or epipharynx, or the teeth for that matter. Having had experience with shoulder pain that was the result of a very minute apical tooth abscess, I mention the teeth. Rhinologic examinations require special equipment. I appreciate Dr. Rhoads' daring ability, but I wonder how he can be sure there is an infection in the epipharynx, for example, just because there is a gland in the neck. Biopsy of the gland may show a malignant growth in the epipharynx.

Routine temperature recording is an excellent procedure, and should be stressed. I find that in our clinics residents have to be told again and again to do this. It is embarrassing to dismiss a patient from the hospital only to find that he is carrying a temperature of 99 or 101° on his return home.

Systemic infection as the result of chronic sinus infection is likewise debatable. I fail to find many systemic conditions associated with chronic maxillary sinus disease, or ethmoids which are draining or being irrigated.

(slide) In a critical study of 150 cases of epipharyngeal pathology in which all the evidence was against the epipharynx, and all other foci were eliminated, there were eight cases of chronic fever of unknown origin. These cases had been studied thoroughly by an internist, and it was only when the pathology in the epipharynx was discovered, consisting of lymphoid hyperplasia, formation of crypts or chronically inflamed furrows, that the diagnosis was established. In one case of asthma we found a pharyngeal bursa as the primary cause. Six additional cases with fever, proved to have epipharyngitis; these were acute cases lasting only a few days. One case of tuberculosis which was primary in the epipharynx also had a tuberculous lesion in the larynx which was previously known.

I point that out because I feel that the otolaryngologist can perhaps better evaluate the presence of pathology in the epipharynx, than one can by the finding of a gland or glands in the neck.

DR. SHERMAN L. SHAPIRO: I should like to ask Dr. Rhoads' opinion about an old discarded method of treatment in foci of infection in the nose and throat; that is, the question of autogenous vaccines, and what his experience has been in this method of therapy.

DR. O. E. VAN ALYEA: I think the internist can offer a great deal of help to the otolaryngologist with his recent knowledge of antibiotics, and perhaps because of more intensive work-up of the bacteriologic factor than the otolaryngologist ordinarily has time for.

Also, I would like to corroborate Dr. Rhoads' gradual discard of penicillin mist as a means of therapy so far as nose and throat infections are concerned. Perhaps it would be applicable to chest infections, but I think it is generally felt by otolaryngologists that penicillin in any form locally can better be omitted in treatment of nose and throat conditions.

I wonder if he has encountered local pharyngeal reaction to aureomycin, a very red throat and edematous palate such as we see occasionally. We encounter several such cases every month in individuals who have been given aureomycin for several days for treatment of acute pharyngitis. The sore throat does not improve and when the patient gets to the otolaryngologist there may be a quite pronounced redness and edema.

DR. FLETCHER AUSTIN: Dr. Rhoads brought up the question of allergy. I would like to ask if he feels that allergy persists for any length of time without infection appearing and, at that time, which is most important in production of symptoms, the allergy or the infection.

DR. THOMAS C. GALLOWAY: I have watched the development of Dr. Rhoads' ideas since we were both residents at Cook County Hospital. He has reached his conclusions on a very fine cumulative bacteriologic technic along with clinical observation, and has a solid basis for his ideas. I should like to ask him to rate, as to importance, foci of infection. I cannot quite agree that sinuses are so important as foci. It seems to me that the treatment of foci of infection has fallen into disrepute partly because of careless surgical work. If secondary foci are manifest, for example in heart or joints, it must be obvious that every bit of tissue which harbors infection should be removed. How important are the granular follicles in the pharynx, especially in allergic individuals, and the true lingual tonsils?

DR. PAUL RHOADS (closing): Perhaps my statements have been a little too sweeping. As to the significance of glands in the neck, however, I will not back down on the statements I made. Possibly there is a difference in interpretation. We would be pretty stupid if we could not recognize a hard gland that stood out alone as a signal that there might be some malignancy present. I think

that has more significance than a chain of small glands extending all the way down that are not particularly hard.

I am well aware of our shortcomings in endoscopy of the nasopharynx, and otolaryngologists know more about that than do internists. I draw my conclusions from the symptoms and from the bacteriologic findings in the nose and throat. Small children are more apt to have easily palpable glands than older children because they have a larger amount of lymphoid tissue. Clinical experience helps to differentiate a pathologic swelling of glands from normal lymphatic enlargement. I still think that a chain of glands in the posterior triangle usually means infection in the nasopharynx or epipharynx, if that is the proper name.

If one has ever suffered from acute sinusitis due to pneumococcus and streptococcus, he knows the distressing pain and ache all over the body. Many patients with rheumatoid arthritis have marked infection in the sinuses. Here again we consider the association of a localized lesion with a systemic condition, and I still think that very often such an association exists.

Dr. Galloway asked that I rate the different types of foci according to importance. I do not think there is any way of doing that. It depends a great deal on the type of organism found. But I would say that when you see tonsils with extension of redness to surrounding structures, a great deal of scarring, or small abscesses in the crypts, you are likely to be dealing with important foci. Devitalized teeth are important sources of infection; we have shown by culture that this is true even though they do not show rarefaction at the root. But I do not think they are foci of infection as often as the tonsils are.

As to lateral lymphoid bands in the nasopharynx, these are the result of drainage from the epipharynx. Dr. Galloway will recall that we made cultures of this lymphoid tissue after it was removed and ground up in sterile broth, and often found hemolytic streptococci although surface cultures did not show them. They had about the same quantitative bacteriologic content as the tonsils. That type of inflammatory tissue probably can be a real focus of infection. The urinary tract, too, is often such a focus.

Autogenous vaccines given in small doses over a long period, with the idea of desensitization, have a definite field of usefulness in allergic persons, particularly in those with asthma. I doubt, however, that we get a result from stimulating the body to produce large amounts of antibodies as in immunity against diphtheria. I

think an allergic condition can exist in the nose and throat for a long time without infection, in those who have dust or feather sensitivity, for instance. Patients who are constantly in contact with pneumococcal and streptococcal infection in this climate are quite likely to develop infection of the respiratory tract made worse by their allergic state.

We have seen local reactions to aureomycin. I think the use of lozenges containing small amounts of antibiotics is a pernicious thing. The antibiotic content is not sufficient to kill the micro-organisms but the constant use of these lozenges produces sensitivity reactions. In the case of aureomycin the growth of yeast is promoted and that is not good. As I said before, we still think there is some field of usefulness for penicillin dust, but it is more limited than was at first believed.

A Study of the Parotid Gland with Reference to the Origin of Some of Its Tumors

ELMER A. FRIEDMAN, M.D.

(Abstract)

From a study of so-called mixed tumors of the parotid gland, it seems that a small percentage of such tumors contain tissue which is histologically indistinguishable from true cartilage and, on a microscopic basis, one would be forced to say that true cartilage does exist in some mixed tumors of the parotid. However, when one carefully notes the subtle graduation throughout the entire range of myxomatous tissue blending into this cartilage, one is forced to conclude that they are but variants of the same tissue. Since this myxomatous tissue is an epithelial product rather than a mesenchymal one, the so-called cartilage is also epithelial in origin, and mixed tumors are of purely epithelial origin. In addition, no cartilage of cartilage-like structure which could be considered as a favorable anlage structure was seen in the parotid of the newborn.

We have confirmed the observation of Neisse concerning the constant presence of "adenoidal lymph nodes" in the parotid of the newborn. Because of their similarity of appearance and structure, it seems most reasonable to assume that these "adenoidal lymph nodes" are the origin of the adenolymphomas of the adult parotid gland.

DISCUSSION

DR. THOMAS C. GALLOWAY: This is a highly technical paper and it is obvious that Dr. Friedman has been very thorough in his observations. His conclusions seem to agree with those of Ringert, who considered that these tumors arise from a bipolar salivary type cell with hyaloid secretion. Mucin is closely allied chemically to cartilage. Tumors of the parotid are peculiar. While they do not metastasize early, in my experience they almost always finally undergo malignant degeneration from multiple centers. If they are interfered with, if the capsule is broken or they become infected, they change their course completely, grow rapidly, necrose and produce infection of the surrounding tissue and the patient usually dies within one or two years. It is important to remember that they are encapsulated tumors. In my experience they do not surround the facial nerve unless they have been tampered with or are late malignancies. They must be taken out by the most meticulous dissection, because if some of the capsule is left, or if the capsule is ruptured, they tend to spread rapidly.

One may speculate that they probably arise from misplaced embryonic rests. I operated on a 22 year old nurse about ten years ago, who is now well. Her sister, an identical twin, had a similar tumor operated on two years before and died following the operation. It is interesting that these tumors, even when completely removed, may recur as late as from nine to 30 years following operation. We are all optimistic about results but cannot be sure until we have had a chance to see our cases very much later.

I want to congratulate Dr. Friedman on this fine histologic presentation.

DR. IRWIN D. HORWITZ: We have seen a fair number of these tumors at the Tumor Clinic of the University of Illinois. We have a slightly different classification; tumors of the type shown are called muco-epidermoid carcinoma. With the connotation of "carcinoma" added to "mixed tumors" it behooves the general practitioner to treat these tumors in the proper manner.

Dr. Galloway mentioned Ringert's very beautiful work. He explained the myxomatous stroma by bipolar secretion, so if one assumes that the intraductal system becomes blocked, the secretion will break through the acini. If this continues it will simply swell the loose areolar tissue and form a myxomatous stroma. We call this a fibro-myxo-epithelial type. This is in contradistinction to the basal epithelioma type which is subdivided into two types; solid

and cystic. The basal epithelioma type is about one-third as common as the myxomatous type.

(slide) This solid tumor we classify as fibromyxo-epithelial type of salivary gland tumor. One theory is that these areas which are sometimes thought to be cartilage are not true chondrocytes and are simply epithelial cells broken off from the acini and caught in the mucoid mesh. They do not act like sarcomas; they act like epitheliomas; they spread by extension and they do metastasize. Some that we have seen required neck dissection, and we feel that meticulous dissection is necessary. If the tumor surrounds the facial nerve we feel that we should remove it whether or not we cut the facial nerve. As Dr. Galloway mentioned, once you light these up they become very active. X-ray has no effect; surgery is either a cure or a death warrant. If the capsule is broken during surgery rapid recurrence will follow. If one is in doubt whether the tumor is benign or malignant, one should take it out completely and forget about the facial nerve. In the clinic we see cases from all over the state that we cannot help, which should have had more radical surgery in the beginning.

DR. ELMER A. FRIEDMAN (closing): I wish to thank the discussors for bringing in some of the clinical aspects which were not a part of the paper but which, to the practicing otolaryngologist, make it much more interesting.

Intranasal Chondrosarcoma

LAWRENCE J. LAWSON, M.D.

(Abstract)

A chondroma is a firm, lobulated, grayish benign tumor. The cells are arranged singly, not in groups. The tumor is relatively non-vascular. It is liable to undergo myxomatous degeneration and often becomes calcified. Growth is slow, and histologically there is evidence of a high degree of differentiation. It is benign but is capable of local invasion and tends to recur.

A chondrosarcoma gives specific evidences of malignancy. These are: poorly formed intercellular matrix, increased cellularity, irregular nuclear patterns and obvious accelerated growth at the margins of the lobules.

Chondroma and chondrosarcoma rarely involve paranasal sinuses and intranasal structures. The intricate anatomy involved usually precludes complete eradication in the sense of eradication with safe margin. The results of irradiation therapy are still disappointing. A new case is presented and another reviewed to illustrate the different pattern of behavior likely to be encountered in chondrosarcoma intranasally at the opposite ends of the life span. Rhinologists faced with the problem will still have to weigh the problem of recurrences following palliative treatment with the problem of functionally and cosmetically undesirable results of attempted complete eradication.

DISCUSSION

DR. JOHN R. LINDSAY: When Dr. Lawson asked me to discuss this paper I told him that my limited experience scarcely qualified me to do so. The main point I wish to bring up is how to deal with this tumor when we encounter it in a patient in the younger age group. There is no question but what Dr. Lawson's palliative treatment was correct for his patient, since she was 76 years of age.

We are not likely to be helped too much by the pathologist's report, as Dr. Lawson pointed out, because to differentiate between chondroma and chondrosarcoma is not always possible on the basis of the sections. It is true that the age of the patient has to be considered; the rate of spread also must be considered. I think in a young patient we must assume that this could be a sarcomatous type of tumor, or has the potentialities of one.

It is apparent that we cannot depend on x-ray or radium to eradicate this type of tumor. I think our only hope of getting a satisfactory result in a young patient is by radical exenteration, or by removal followed by electrocoagulation in the attempt to destroy any tumor tissue that may have been missed. I think we must think of this as the basis of adequate treatment. Granted, it will depend on the extent of the tumor when first seen whether such treatment will be possible.

DR. STANTON A. FRIEDBERG: I enjoyed Dr. Lawson's presentation very much, and would like to repeat one or two points he mentioned in order to emphasize the relatively slow growth of this tumor and to indicate what can be done in the way of palliation.

(slide) This patient is 63 years old. Information obtained when we first saw her in 1948 indicated that the symptoms had apparently existed since 1941 and that a diagnosis of chondrosarcoma had been made as far back as 1944. In that year x-rays showed extensive in-

volvement of all the nasal accessory sinuses. At that time and again in 1947 she received x-ray therapy without benefit. You will note the disfiguring enlargement of the nose in 1948. Review of the slides confirmed the diagnosis of chondrosarcoma. There were no clinical evidences of metastases. We felt some type of operative procedure should be done simply to enable her to breathe and to relieve the deformity of the face.

At operation we left a portion of the nasal tip for prosthetic support, removed a huge tumor of the septum and as much of the massively invading growth from all sinuses as could be visualized. We have used electrocoagulation on several occasions since that time, as residual tumor appears. The patient wears a prosthesis and is seen at monthly intervals. She is quite comfortable, there are no metastases, and three and one-half years have elapsed since the operative intervention.

In think this substantiates what Dr. Lawson has said, that these are slow-growing neoplasms, and that in the presence of an extensive tumor in an older individual, a good deal can be done with palliation.

DR. JOSEPH G. SCHOOLMAN: I would like to mention a point with reference to roentgenograms of all sinus tumors, that is, the sclerosing reaction one finds about the frontal sinuses. We speak of this in our group as the Haas sign, because Dr. Haas first called attention to this sign in the literature, and has been rather emphatic in calling it to our attention. Another thing in x-ray films is the importance of a view of the base of the skull in malignant neoplasms of the sinuses and nasopharynx because of the frequency of extension along the base beyond the scope of surgery. There is no question but what adequate surgery (we do not like the term radical) is necessary in all malignancies.

Another point to be kept in mind is the age of the patient; not the numerical age, because an individual of 76 whose parents and grandparents lived to the age of 90 is much younger than one of 60 whose parents and grandparents lived only to their late 50's. That has a good deal to do with determining the life expectancy, and one should consider this factor in terms of definite treatment.

DR. BRUNO BLUMKLOTZ: I should like to report two cases on which surgery was performed. One was a chondrosarcoma of the ear, and a mastoidectomy was sufficient to keep the patient alive since 1946. The other case was a man with a chondrosarcoma of the nose and sinuses, whom we were able to keep alive for eight and

a half years without radical surgery. He died finally of extension of the tumor into the base of the brain. When we saw him first the tumor had extended from the left ethmoid and antrum through the septum into the right ethmoid and right antrum. There was x-ray evidence of involvement of the left orbital floor. We operated by external and internal surgical approach and the patient was well for three years. He was reoperated on on two occasions and was able to work as a carpenter for seven and a half years. Finally we had to remove the left eye and hard palate, but were not able to stop the progress of the tumor. To decide on adequate surgery may be difficult, when the mutilating effect makes social adjustment of the patient impossible.

DR. THOMAS C. GALLOWAY: Dr. Soper and I reported a case in which the tumor obliterated the entire sphenoid bone. It was removed with a curette quite satisfactorily up to pulsating dura by a central "coring" technic, although it recurred in four years.

DR. LAWRENCE J. LAWSON (closing): I wish to thank those who contributed to the discussion. Dr. Lindsay has reemphasized that a different course of treatment may be required, depending on whether the tumor occurs early or late in life. In the young individual the tumor is more active and requires more radical treatment.

Dr. Friedberg, in showing the slide of a patient on whom operation was performed, emphasized that all the evidence and all the indications must be considered in deciding the proper course of therapy.

Dr. Schoolman's comment reminds me that I should stress the desirability of having stereoscopic films to ensure study of the entire extent of the pathology. Some roentgenologists present masked films which leave peripheral regions and the base of the skull unstudied.

Dr. Blumklotz emphasized a point made in the paper, that if surgery is sufficiently radical to destroy the tumor, the sacrifice of tissue is such that deglutition and respiration are interfered with, and the cosmetic result makes social adjustment most difficult.

Abstracts of Current Articles

EAR

Idiopathic Ménière's Disease.

By Dr. Adolfo Azoy, Professor of Neurootology, Neurological Institute, Barcelona, Spain; from the *Acta Otorinolaringologica Espanola*, Vol. I, 1951.

The author classifies cases with the clinical picture of vertigo, tinnitus and deafness into three main types: idiopathic Ménière's disease, Ménière's syndrome and pseudomenieres symptom complex.

Under idiopathic Ménière's disease, he includes solely those cases of labyrinthine hydrops. The author admits that the the well known triad need not always be present in hydrops, recognizing the fact that there may be purely cochlear involvement without vestibular symptoms. He believes that the concept of stasis or hydrops can account only for some of the cases and that ischemia in effect accounts for a much larger proportion of the total.

The author lists the following factors in the pathogenesis of Ménière's disease: intracellular biochemical phenomena, angioneurotic phenomena, sympathetic-parasympathetic control, endolymphatic-perilymphatic pressure balance, metabolic dysfunction, endocrine dysfunction, allergy and pathergy.

Abnormalities in the sympathetic-parasympathetic balance result in altered tonus with vasoconstriction or vasodilation, which produce in the one case ischemia, and in the other hyperemia, stasis, transudation, and hemorrhage. Where ischemia is prolonged, spasm, stenosis, and eventual obliteration of circulation may result. The author lists a series of observations from 200 cases of Ménière's, 100 males and 100 females:

The predominant symptom is vertigo and following in frequency tinnitus, headache, and deafness. Vertigo usually appears in acute episodes, with periods of minor dizziness between attacks. Few patients recognize this dizziness as a rotary sensation, but the majority will admit the similarity of their subjective symptom to that brought on by vestibular stimulation.

Positional vertigo may be observed in the majority of cases of Ménière's; rotary nystagmus can be observed frequently. Many

cases have suffered minor headaches, tinnitus, vertigo, and deafness before the onset of an acute disabling attack. Many patients attribute their illness to liver, gastro-intestinal, and endocrine dysfunction.

Examination of hearing offers much help in studying the course of the disease and the efficacy of treatment, since fluctuations in hearing reflect the changes in endolymphatic tension. Islands of deafness are frequent. There is no correlation between the degree of deafness and the intensity of vertigo. The most severe deafnesses are found repeated or prolonged attacks of hydrops without other symptoms being severe. Some cases reveal loss of acuity for lower frequencies only. Painful hyperacusis is common, with or without evidence of "cochlear fistula." Diplacusis is a very constant finding. Hydrops is usually unilateral, but when bilateral, the acute attacks are manifested only in one ear. The signs of impaired equilibrium are discrete and compensated, with only mild lateralization to the diseased side or to the more involved side if bilateral. Between attacks spontaneous nystagmus is rare, but positional nystagmus may be observed; this is more common in the horizontal position.

The various technics of labyrinthine tests are mentioned as well as the importance of complete physical and audiologic examination. This article does not concern itself with therapy.

ALFARO.

The Weber Test In Fenestration.

Dr. Mario Rius, *Anales de Oto-Rino-Laringologia, del Uruguay*, Vol. 20 Part 4, Montevideo, 1950.

The importance of the Weber test is discussed by the author in the light of his experience in 38 cases of fenestration. The author finds, as has been reported by Juers and others, whom he quotes, that the Weber test is lateralized to the operated ear following operation in most cases. There are some, however, in whom the Weber lateralizes to the opposite ear, or is diffuse. A total of 26 cases showed a Weber lateralizing to the operated side postoperatively. Of these, there were 23 classified as good results (15 to 45 db gained). There was one of poor gain and there were two cases of closure of the fenestra. There were five cases in whom the Weber was partially lateralized to the operated side; forks 512 and 1024 were lateralized in each case. Of these, there were four cases with good results, (25 db gain), and one case without gain. There were two cases of unilateralized Weber, and five cases in whom the Weber lateralized to

the unoperated ear. Of these, three had probable labyrinthitis with negative fistula reaction and two probable hydrops with positive fistula reaction.

Rius considers lateralization complete when the forks lateralize from the three positions of vertex, forehead and chin. This lateralization may be found with all forks used or with only some of the forks used. The author notes the interesting finding that in some of the cases who had good postoperative gains, forks 512 and 1024 lateralize to the fenestrated ear whereas forks 128 and 256 would lateralize to the unoperated ear. Rius does a Weber-balance test wherein he places the vibrating tuning fork first on one maxilla and then on the other. In the performance of this test, he finds that in many cases the lateralization will be towards the operated ear regardless of which maxilla the fork is placed upon. There were some cases, however, in whom the fork was heard equally well in both ears, and still others in whom the Weber lateralized to the unoperated ear. Then there were some cases with lateralization limited to the homolateral ear, and some with lateralization towards the opposite ear. In other words, some patients with the fork on the right maxilla could hear only in the right ear, whereas others with the fork on the right maxilla could hear only in the left ear. The author is interested in this phenomenon, namely the heterolateral-balance test; it had previously been described by Barany, whom he quotes; the latter found several cases "in whom bone conduction was more intense in an ear when the vibrating tuning fork is placed in a point opposite that of the ear being tested."

ALFARO.

The Influence of Tensor Tympanic Muscle on the Mechanical Transmission of Sound Vibration of the Middle Ear, Experimental Investigation by the Cochlear Response.

J. Ukida, J. Oto-Rhino-Laryngological Society of Japan 55:1-7 (Jan.) 1952.

1. Loading of the tensor tympani muscle caused a reduction of the response gain. Provided the loading weight remained within a limit, the normal value of response without loading was immediately restored, when the muscle was released of the load. When the load was so great as to surpass the limit, the normal response was not restored by the release. This limit, 15-20 gram weight and about 20 db voltage loss, may be considered as the physiological limit of the mechanical stretching of the muscle.

2. Increase of the load within this limit resulted in increased loss of response, which was more marked in low tones than in high tones.

3. Increase of the load above this limit also caused increased loss of response, which, however, occurred uniformly for all frequency bands.

4. Section of the muscle was immediately followed by loss of response in various frequencies which amounted at the most to only about 10 decibels.

AUTHOR'S ABSTRACT.

Studies on "Fowler Phenomenon" Chapter II: Studies on the "Alternate Binaural Loudness Balance Test" with Regard to Obstruction and Nerve Deafness.

Y. Shiotani, J. Oto-Rhino-Laryngological Society of Japan 55:14-30 (Jan.) 1952.

The author applied the "Alternate Binaural Loudness Balance Test" on 77 cases of obstructive deafness and 25 cases of nerve deafness, using 49-A Audiometer.

Recruitment of loudness occurred only in cases of nerve deafness with unequal threshold of bone conduction between the two ears, while it does not appear in obstruction or nerve deafness with equal threshold of bone conduction between the two ears.

From this result, the author concluded that the "Alternate Binaural Loudness Balance Test" is very important for differential diagnosis between nerve deafness and obstructive deafness.

AUTHOR'S ABSTRACT.

The Characteristics of Electrical Cochlear Response Under the Influence of Various Conditions Applied To the Conductive System of the Middle Ear.

J. Ukida, J. Oto-Rhino-Laryngological Society of Japan 55:8-14 (Jan.) 1952.

The author studied the change of response intensity as influenced by the experimental interference applied to the conductive system of the middle ear of cats and guinea-pigs.

(1) Incision of the tympanic membrane produced a fall of response voltage of not more than 20 db. Articulation of spoken voices was found reduced.

(2) Circumcision of tympanic membrane caused a voltage loss by 25-34 db. or more, and a shift of stimulus sound pressure by 30-

60 db. in all frequencies. Removal of malleus or incus entailed a more marked loss.

(3) Mercury instillation in the attic produced a loss of 2.5-5.0 db in all frequencies. When the middle ear cavity was filled with mercury, the response fell in all frequencies especially in the high frequencies above 2048 c.p.s.

(4) In a case of chronic otitis media the response was uniformly decreased by 14-23 db over the whole range of frequency.

AUTHOR'S ABSTRACT.

Statistic Study of Mastoid Cell Development in Cases of Chronic Otitis Media as Observed in X-ray Pictures.

Shiro Hayashi, *J. Oto-Rhino-Laryngological Society of Japan* 54:311-316 (June) 1951.

In 1918 Wittmaack advanced his theory that chronic otitis media develops in children whose process of mastoid cell pneumatization is interfered with. In 1935 Barth, and in 1939 Mittermeier, demonstrated repneumatization of these cells which disappeared incident to chronic otitis media. Hayashi examined x-ray pictures of the temporal bone of 893 patients, 561 of whom were males and 332 females, who had chronic otitis media. On the whole the affected ears with chronic otitis media showed poor pneumatization. His classifications were:

A. Normal or better pneumatization	1.4%
B. Pneumatization slightly suppressed	3.6%
C. Pneumatization moderately suppressed	11.6%
D. No pneumatization	83.5%

He records that the process of pneumatization proceed as long as the inflammatory process was chiefly confined to the tympanic cavity. There was no evidence of further development of cells when the inflammatory process extended to the attic, antrum, and mastoid cells. In cases of cholesteatoma the pneumatization completely ceased. In cases of unilateral chronic otitis media, the pneumatization was interfered with only in the affected ear.

HARA.

NOSE

The Olfactory Sensation in Dream with Special Reference to Dreams of Patients of Chronic Sinusitis.

M. Ichibara, *J. Oto-Rhino-Laryngological Society of Japan* 55:39-46 (Jan.) 1952.

No detailed report on the olfactory sensation in dream is found. Under the impression that such symptoms as headache, reduced attention, and poor memory in patients of chronic nasal sinusitis may have some connection with dreams in their sleep, the author collected statistics for the following 600 subjects:

- 1) Samples of out-patients in general of our clinic—100 males and 100 females.
- 2) Samples of chronic sinusitis patients—100 males and 100 females.
- 3) Control samples consisting of students and nurses—100 males and 100 females.

The following incidences were recorded among 453 dreamers:

<i>Classification</i>	<i>Incidence</i>	<i>Percentage</i>
Visual	196	43.3
Auditory	108	23.8
Taste	39	8.6
Pain	33	7.3
Smell	13	2.9

Six males and seven females experienced smell in dream, the quality of which was generally related to meals. Of these 13, seven subjects possess unusually delicate discrimination in odors in their everyday life. For ten subjects the experience of the smell in dream had left so strong an impression that they could accurately state the date of the experience.

Patients of chronic sinusitis dreamed more frequently than the controls. Many unpleasant dreams were reported, frequently with unpleasant feeling or headache on waking. Such trend was more pronounced among female patients.

AUTHOR'S ABSTRACT.

PHARYNX

Clinical Observation of Malignant Tumors of the Oral Cavity and Pharynx.

1. Nakagawa, J. *Oto-Rhino-Laryngological Society of Japan* 55:46-51 (Jan.) 1952.

Nakagawa reviewed the case records of 2247 patients who were seen in the radiological therapeutic Department of the Japanese Cancer Hospital from October 1, 1946 to October 1, 1949, over a three-year period. Among these were 204 patients who had developed neoplasm of the oral cavity and pharynx. Of the tumors of the oral cavity 167 were carcinoma, which were most frequently found in the tongue, then in the dental ridges, cheeks, soft and hard palates in the order named. There were 27 cases of sarcoma of the oral cavity. Of the 56 cases of tumors involving the pharynx, 21 were carcinoma, and 30 were sarcoma. Among them were nine carcinoma and 17 sarcoma of the tonsils; four carcinoma and 12 sarcoma of the nasopharynx. Thus, in the oral cavity, carcinoma was much more frequently encountered than sarcoma; but in the pharynx this ratio is reversed, the proportion being three of sarcoma to one of carcinoma. These growths occurred most frequently in the ages 40-70, males 3:2 for carcinoma and 2:1 for sarcoma. These patients first consulted the physician six months to one year after the onset of the initial symptoms.

HARA.

LARYNX

Considerations in the Treatment of Laryngeal Cancer.

Cusi, M.: *Acta Oto-Rhino-Laringologica Ibero-Americana* 2:2, Barcelona, 1951.

The author reviews the history of treatment in carcinoma of the larynx. He analyzes the published statistics of the various surgical techniques and evaluates the relative merits of radium, x-ray therapy and surgery.

In essence, the author concludes that radiation is the treatment of choice to be followed in the event of recurrence by surgery. He feels that surgical mutilation can be avoided in so many cases by modern techniques of radiation therapy that it is justifiable to postpone surgery until it is ascertained that radiation has failed to effect a cure.

The author favors radium therapy over x-ray.

ALFARO.

TRACHEA

Roentgenologic Considerations in Tracheo-Esophageal Fistula Without Esophageal Atresia.

Leigh, T. F., Abbott, O. A., and Hopkins, W. A.: Radiology 51:871-877 (Dec.) 1951.

The available literature on tracheo-esophageal fistula without esophageal atresia is reviewed, particularly from the point of view of clinical symptomatology and radiologic diagnosis. Few of the reported cases have been accurately diagnosed radiographically.

Two cases are reported briefly, chest roentgenograms with lipiodal installations are shown. Suggestions for improving the radiographic diagnosis of the type of anomaly are made.

JORSTAD.

BRONCHI

Bronchogenic Carcinoma.

Salvestrini, H., Luchini, A., and Marsano, A.: Revista De Otorrinolaringologia, Vol. 11 (Mar. 31) 1951, Santiago, Chile.

The author's review of the subject is based on statistics of the Department of Thoracic Surgery of the Catholic University Hospital. In 401 cases seen over a two year period, 73 had bronchogenic carcinoma, and of 133 surgical cases 27 (20%) were for bronchogenic carcinoma. The location of the tumors was 62 central (bronchial), and 11 peripheral. Seventy per cent were of the squamous cell type, 17% adenocarcinoma, and 13% undifferentiated. The frequency of presenting symptoms was as follows: 60% of patients had cough, 50% loss of weight, 45% pain, 40% sputum, and 20% hemoptysis.

The difficulty of early diagnosis in peripheral lesions is stressed; in each of the 11 cases diagnosis was made by x-ray, often with total absence of localizing symptoms. In three of these cases, the first symptoms were referred to a metastatic lesion, two of which were intracranial.

The authors urge an early clinical suspicion of cancer to obtain early diagnosis by the various technics at our disposal. The value of bronchoscopic examination in all cases is stressed: in those where x-ray findings are completely diagnostic, as well as in those where x-rays merely suggest the possibility of cancer. In many cases of course, the tumor cannot be visualized radiologically, but

indirect signs of observation or pneumonitis in bronchopulmonary segments are presumptive evidence of tumor. In at least 48% of the cases that were bronchoscoped, gross inspection and biopsy proved the diagnosis of cancer. In many other cases when the tumor could not be visualized, cytologic examination of the aspirated secretions revealed a positive diagnosis.

Exploratory theracotomy must be done in some cases. The authors consider radiation therapy of no value; they even believe that inoperable cases on whom radiation is used do worse than if left untreated. Of 14 cases operated upon for resection, 11 were pneumonectomies and three lobectomies; ten of these had survived for periods from eight months to three years, with four showing some metastatic involvement.

ALFARO.

ESOPHAGUS

Primary Melanosarcoma of the Esophagus.

Burnett, J. M., and St. John, E.: Radiology 57:868-870 (Dec.) 1951.

Four cases of primary melanoma of the esophagus have been reported. This case is presented in the form of a short case report, spot film of the esophagus showing the obstruction, mass, gross, low-power and high-power views of the tumor.

The lower end of esophagus, including the tumor, was resected. Follow-up examination eight months later was reported as "negative barium swallow." Patient died at home two months later. No autopsy was obtained.

JORSTAD.

MISCELLANEOUS

Cerebellopontine Angle Tumors: Their Roentgenologic Manifestations.

Hodes, Philip J., Pendergrass, Eugene P., and Dennis, John M.: Radiology 57: 395-406 (Sept.) 1951.

A series of 183 patients with cerebellopontine angle tumors who were operated upon in the University of Pennsylvania Hospital are reviewed from the standpoint of roentgenologic manifestations. Of this group, 134 had eighth nerve tumors, 18 had meningiomas, 16 gliomas, seven cholesteatomas, three hemangioblastomas, and one

each had metastatic carcinoma, encapsulated hemorrhage, chondrosarcoma and chondromyoma.

Localizing roentgen findings were demonstrated in 85% of the acoustic nerve tumors and in almost 50% of the meningiomas. In 17 patients with gliomas of this region only one had radiographic abnormalities demonstrable in the petrosal apex. Fifty per cent of those with cholesteatomas showed erosion of the internal auditory canal.

Six case reports with prints of radiographs are included.

JORSTAD.

Herniation of the Lung in the Cervical Region.

Reinbart, H. A., and Hermel, M. B.: Radiology 57:204-207 (Aug.) 1951.

Two cases of herniation of the lungs in the cervical region, posterior to clavicle are reported. Congenital hernias are associated with weakness of the chest wall and increase in intrathoracic pressure. The acquired types may be spontaneous with usually an underlying congenital weakness of the chest wall or they may be the result of weakening of the thoracic wall by trauma or disease. Brief case histories of its occurrence in a 42 year old and a 47 year old man are given.

The outstanding symptom is a presence of a soft rounded mass in the supraclavicular fossa which is crepitant and emits breath sounds on auscultation. Four radiographs show characteristic findings. Surgery is the definite treatment combined with treatment of the underlying condition. Prognosis is good.

JORSTAD.

Malignancy in Adenomas of the Thyroid.

Labey, F. H., and Hare, H. F.: J. A. M. A. 145:789-696 (Mar. 10) 1951.

The authors report an incidence of 10.04 per cent of malignancy in 1,971 discrete adenomas studied in their clinic and contend that this incidence is too high to justify delaying surgical intervention against such tumors.

They believe that all discrete adenomas of the thyroid, however small or however large, and even in young people, should be removed as a prophylactic measure against the later occurrence of malignant degeneration in them. They refer to their experience with 428 pa-

tients with cancer of the thyroid gland, mentioning that it is evident to them that the five year survival rate without recurrence of the disease is very definitely correlated with whether or not the malignant neoplasm is entirely within the capsule at the time of the removal of the discrete adenoma. Prophylactic removal of all discrete adenomas would do much to lower, if not abolish, the occurrence of cancer of the thyroid. The authors discuss the indications and method of treating cases in which postoperative irradiation has been added to the surgical treatment. They also discuss radioactive iodine.

BOIES.

Complicated Fractures of the Maxilla.

Murphy, D. L., Murphy, E. S., and McNichols, W. A.: *J. A. M. A.* 145:614-620 (Mar. 3) 1951.

The authors emphasize the importance of having a group of physicians in each locality who are willing to care for maxillofacial injuries. Prompt reduction gives best results. Modern external fixation and extension is most satisfactory in regard to comfort to the patient and to the absolute fixation of the fragments.

External fixation of fractures of the mandible can be used for almost any fracture, and they believe that an open type of operation should not be done.

BOIES.

The Toxic Effects of Antihistaminic Drugs.

Wynngaarden, J. B., and Seevers, M. H.: *J. A. M. A.* 145:277-283 (Feb. 3) 1951.

Severe toxicity from antihistaminic compounds is rare, but serious reactions have resulted from idiosyncrasy or from over-dosage. Twelve previously unreported cases of toxicity are presented, seven of them convulsive, two of them occurring in adults. Eleven fatal cases are reviewed, in eight of which the patients were children under the age of two years.

Infants and children seem predisposed to development of convulsions from over-doses, and the mortality rate in infants in whom convulsions develop is very high. Agranulocytosis is another serious development which has been reported nine times with one death.

The treatment of these reactions is purely symptomatic.

It is imperative that physicians be aware of the potential hazard of the antihistaminic compounds, as well as of their great usefulness.

BOIES.

Tracheotomy for Prevention of Pulmonary Complications in Postoperative and Severely Debilitated Patients.

Atkins, J. P.: J. A. M. A. 146:241-244 (May 19) 1951.

The author contends that it has not been generally recognized that when there is a threat of obstruction in the upper airway, this is an important indication for tracheotomy. It will prevent anoxic episodes from which there are damaging sequelae. It provides an easy access for aspiration of the tracheobronchial tree so as to protect the patient from aspiration pneumonitis. In extensive operations about the mouth, pharynx and neck there is danger from obstruction by edema, from interstitial hemorrhage, and by inability to prevent the entrance of pharyngeal secretion or food into the lung. Two case reports illustrate his point.

BOIES.

Recent Advances in Treatment of Migraine.

Friedman, A. P., von Storch, T. J. C.: J. A. M. A. 145:1325-1329 (Apr. 28) 1951.

The underlying causes of migraine are at present unknown. The authors doubt that any single process or mechanism is responsible. It is suggested that the vasomotor theory is probably the most acceptable one. They refer to the observations of Wolff and his co-workers who have objectively demonstrated a vasomotor imbalance involving spasm and dilatation. The authors comment on the concept that various migraine phenomena are associated with abnormalities in the endocrine system. They state that there still remains a great deal to be known about the relationship of migraine to endocrine equilibrium. They suggest that such concepts of various investigators as vitamin and dietary insufficiencies, allergic conditions, neurosympathetic disturbances, fluid imbalance and toxic colonic, duodenal, and hepatic disorders, as well as various ocular malfunctions, and even trauma to the head and neck are based on very meager evidence. The authors conclude that the treatment of migraine is a complex individualized procedure. Symptomatic treatment is essentially one of pharmacotherapy, and the best results have been obtained with the use of the ergotamine derivatives, notably a compound of ergotamine and caffeine (cafergot). Prevention of an

attack is best accomplished by psychotherapy. However, the use of certain drugs holds promise.

The treatment of migraine has now reached a point where, in most instances, the practitioner can favorably modify the frequency and severity of the patient's headache.

BOIES.

Neuromuscular Incoordination of Swallowing in the Newborn.

McCaulay, J. C.: *The Lancet* 260:1208, No. 6666 (June 2) 1951.

The author suggests the possibility of a syndrome superficially similar to that caused by congenital esophageal atresia but unassociated with any gross anatomical defect. He thinks this should be considered in the differential diagnosis of esophageal atresia or stenosis. He gives a case report to illustrate his point. He remarks that transient disorders of swallowing may occur in newborn babies as a result of prematurity or of obstruction of the respiratory passages by mucus. In addition to organic lesions of the esophagus, congenital abnormalities of the medulla and extreme cases of amyotonia congenita may produce a similar picture. In the case described there was no evidence of any of these. However, the swallowing defect, the irregular breathing, the weak cry and the incoordinated movements of the larynx, with subsequent recovery point to a reversible lesion of the medulla—a temporary partial bulbar palsy. There was no evidence of an intracranial hemorrhage, but possibly there had been some bruising and edema of the medulla which subsequently disappeared. A more likely explanation is that there was an immaturity of the bulbar centers, with a consequent failure of coordination of swallowing, laryngeal movements, and breathing. It is suggested that this is supported by some careful observations of Peiper (1942) Mschr. Kinderbeilk. 90, 37, who investigated the temporary swallowing and breathing disturbances of newborn babies and concluded that they were due to immaturity of the medullary centers.

BOIES.

Fractures of the Sphenoidal Sinus with Cerebrospinal Rhinorrhoea.

Lewin, W., Cairns, Sir H.: *British Medical Journal*, No. 4696 (Jan. 6) 1951.

It is now generally accepted that cerebrospinal fluid rhinorrhoea following a head injury indicates a dural tear in relation to a fracture involving the paranasal sinuses, and that a fascial repair of the

torn dura is required as an insurance against intracranial infection in the future. Most of the fractures involve the frontal or ethmoid sinuses. However, in a series of 84 cases of cerebrospinal fluid rhinorrhoea following closed head injury, the dural tear over the sphenoidal sinus was found in 11 (13 per cent). It was the only tear in relation to the paranasal sinuses in five (6 per cent). The main clinical characteristic of these five cases was the profuseness of the rhinorrhoea, due to the fact that the tear involved the overlying cisterna chiasmatica. Another sign which may be helpful in diagnosis is the radiographic demonstration of air in the cisterna chiasmatica, as occurred in one of these cases.

Neighborhood signs, such as evidence of the damage to the hypothalamic region, optic chiasm or carotid artery, were present in nearly half the sphenoid cases, but by themselves they do not necessarily indicate a fracture involving the sphenoid sinus. The preservation or loss of sense of smell is likewise no clinical guide.

Operative repair is urgently indicated. The risk of spread of infection intracranially into the basal cisterns is appreciably higher than with fractures involving the other paranasal sinuses.

Operative repair is difficult and requires a bifrontal flap, usually with division of the falx and sacrifice of one or both olfactory tracts. Three patients underwent successful dural repair and have since been followed for nearly four years. There has been no further rhinorrhoea or intracranial infection, and all are well and working.

BOIES.

Single-Portal-Massive-Dose X-Ray Therapy Technic for Certain Upper Respiratory Tract, Parotid Gland, and Recurrent Breast Cancer.

Friedman, M., and Davis, L. A.: Radiology 57:797-818 (Dec.) 1951.

The authors present the thesis that the radiation dose is 8000 r to a single portal, in four or five weeks. Certain tumors with metastatic nodes unsatisfactorily irradiated with other current technics can be brought into the range of curability by the use of this dosage. About ten years ago they began progressively to increase the total dose delivered to one skin portal on the head and neck from 4000 to 6000 and finally to 8000 r. This technic is indicated for lesions whose deepest extension is not more than 4 cm from the skin.

This technic for fractional external irradiation satisfies the physical and clinico biologic characteristics of certain laterally situated cancers of the upper respiratory tract, salivary glands and recurrent

breast carcinomas. It was employed in 74 cases. Fields measured approximately 8 x 10 cm, quality of beam 1.0 to 2.0 cm Cu. L.v.l. One instance of early and one of late necrosis occurred.

The degree of epidermitis and type of histologic change determine the effectiveness of the treatment at seven, 14, and 21 days as well as the tolerance of the skin. The eventual prognosis is dictated by the most radioresistant portion of the tumor, no matter how small the fraction may be.

Thirty-four figures amply illustrate epidermitis curves, skin reactions, and treatment results.

JORSTAD.

A New Radiolaryngometric Method.

Garciga, C. E.: *Radiology* 57:884-885 (Dec.) 1951.

The author has made a square of lucite (radiotransparent). Over one of its bars a ruler slides from side to side. Fine lead lines have been embedded at 1 cm intervals. Positioning of the apparatus on the side of the neck to be treated is shown by photograph and description. Dots are made on the skin with dermal pencil to coincide with markings on the apparatus. A roentgenogram is taken in profile. The location of the lesion is determined in relation to the pencil marks. The area is then marked with a 10% solution of silver nitrate to limit the area of irradiation. Five figures demonstrate the procedure.

JORSTAD.

Papers Read at the International Course in Audiology in Stockholm, September, 1949.

One of the outstanding events in the field of audiology was the course initiated and directed by Professor Gunnar Holmgren of Stockholm, and given in that city in September, 1950. Approximately 110 otolaryngologists from many countries in Europe and the United States attended. Nine audiologists from the USA participated in the course. For the benefit of those who wish to obtain copies of the professional presentations at that meeting, Professor Gunnar Holmgren has decided to use Volumes 40 and 41 of the *ACTA Otolaryngologica* as the medium for disseminating this information. The following is a resumé of the articles in Volume 40 which will go to the regular subscribers of this Journal. Any one else interested may obtain copies of this collection of authoritative

papers by writing to the editor. The address is Acta-Otolaryngologica, Våpnargaten 6, Stockholm, Sweden. The following are the first 12 papers to appear, all in English.

Addressing his remarks to Her Royal Highness, Princess Sibylla, Professor Gunnar Holmgren of Stockholm presents his inaugural address as an introduction to the Course. The meeting was called at the suggestion of Dr. Sadowki of Tel Aviv, Israel. Professor Holmgren mentions the First and Second International Conferences held in 1948-1949 and expresses the hope that rehabilitation of the deafened will continue along the lines already established.

Hans Engström of Stockholm, in his article, "Microscopic Anatomy of the Inner Ear," explains the embryology, and in detail, well supported by some 20 exceedingly fine plates, presents some high power photomicrographs illustrating minute anatomy of the Organ of Corti.

Arno Saxén, Helsinki, explains his methods of investigating the secretion and absorption of endolymph in the ear of human beings and young dogs. He claims the endolymph comes mainly by diffusion from the perilymph as well as from the cerebrospinal fluid.

J. J. Groen, Utrecht, writes on the "Functional Anatomy of Hearing." Taking speech as the pattern of sound waves perceived by the ear, he analyzes the three elements of pressure (loudness), frequency (pitch) and time, showing how each is dealt with by the organ of hearing with ultimate analysis lying in the higher centers.

"Audiology and the Basic Sciences" is presented by Ira Hirsch, Boston. Discussing the elements of audiology and the background of knowledge which has accumulated for many years, he elucidates the problems of the deafened person under the guidance of otologists. Audiometry, diagnosis, prognosis and therapeutic recommendations, including psychologic evaluation, are outlined. Audiologic therapy and the scientific resources for methods to make best use of residual hearing are discussed. A final note of cooperative action indicates the value of clinical activity based on sound scientific principles.

"Pure Tone Audiometry" is discussed by Henk C. Huizing of Groningen. Electronic equipment first used in 1919 by Dean and Bunch has now been expanded to provide several types of audiometric technique, using pure tones. Not only threshold values by subjective response, but the psychogalvanic method of Bordley and Hardy and the reflex methods of Dix and Hallpike are mentioned. Special techniques, using tape recorders and the classification of audiograms form a part of Huizing's presentation.

Raymond Carhart of Evanston, in his usual lucid manner, makes the "Basic Principles of Speech Audiometry" clear and concise. Illustrating the values obtained when normal listeners hear calibrated speech patterns, he shows clearly the variations in speech interpretation based on the discrimination curves of Davis. The proper use of speech elements in the language being used and results of speech audiometry used in conjunction with pure tone testing can increase our ability to be of practical help to the handicapped patient.

John E. Bordley and William G. Hardy of Baltimore, present their experience in the article, "The Etiology of Deafness in Young Children," in which are the findings in 296 children. Of these, 104 are noted as "cause undetermined." The other 192 are divided among 23 different causes, with from one to 27 cases in each category. Eighty-eight had been exposed to the causative factor "by the time their delivery had been completed." It is stated that of these 88, 60 "should have started their life with normal hearing."

William G. Hardy, Mirriam Pauls and John E. Bordley of Baltimore, outline the "Modern Concepts of Rehabilitation of Young Children with Severe Hearing Impairment." In this group, they include those whose impairment "interferes materially with the psychologic linguistic and social development of the child." Communication is the key-note in the development of these children. In dealing with them, the whole child must be approached by means of several professional disciplines focused on the child at the earliest possible time in his life.

I. Simpson Hall of Edinburgh, in his article, "The Prevention and Treatment of Deafness in School Children," mentions the importance of the new methods for the control of ear infection with antibiotics and early recognition of otopathies. Routine audiometry by screening methods will discover early cases. Hearing aids are of great value in appropriate cases. Hearing analyses after mastoid operations indicate the expected hearing change when the disease is eliminated. Public and professional education can do much to decrease the incidence of hearing impairment.

"Auditory Training and the Development of Speech and Language in Children with Defective Hearing" is presented by T. J. Watson of Manchester. He points out that of the children born deaf, only 5% were totally deaf and the remainder had some residual hearing. Ninety-five per cent had some capacity to hear and methods for using this ability are applicable to approximately 70% of the pupils in the Schools For the Deaf with which he is associated. Marked

improvement in speech and language development is thereby obtained.

"Auditory Fatigue and Adaptation" by Göran DeMaré of Karlstad, Sweden, is the final paper. After an explanation of the methods he used to investigate these two interesting phenomena of the ear, he concludes that they both seem to be an "early neural process." As practical points, he indicates that auditory fatigue may be an important source of error in audiometry and that some ears are much more easily fatigued than others.

Volume 41 of the *Acta-Otolaryngologica* will contain more papers on audiology given at the same course.

CANFIELD.

Books Received

Einführung In Die Rontgenologie.

By G. F. Haenisch, M.D., H. Holtbusen, M.D., and A. Liechti. Pp. xvi+521 with 371 illustrations. Stuttgart, Germany, Georg Thieme, 1951. (Price DM 60.00)

Les Maladies de L'Oesophage.

By J. Terracol, Professor at the Faculté de Medecine de Montpellier. Pp. vi+1038 with 541 illustrations and 5 colored plates. Paris, France. Masson & Cie, 1951.

The 1951 Year Book of the Eye, Ear, Nose, and Throat (October, 1950-September, 1951).

The Eye edited by Derrick Vail, M.D., D. Oph. (Oxon.), F.A.C.S., Professor and Director, Department of Ophthalmology, Northwestern University Medical School; Attending Ophthalmologist, Passavant Memorial Hospital and Cook County Hospital. *The Ear, Nose and Throat* edited by John R. Lindsay, M.D., Professor of Otolaryngology, The University of Chicago, The School of Medicine. Pp. 456 with 133 illustrations. Chicago, The Year Book Publishers, Inc., 1952.

The Battle for Mental Health.

By James Clark Moloney, M.D. Pp. x+105. New York, Philosophical Library, 1952. (Price \$3.50)

Speech Training.

A Handbook for Students by A. Musgrave Horner, lecturer on speech training, Stranmillis Training College, Belfast. Pp. 176. New York, Philosophical Library, 1951. (Price \$3.75)

R For Medical Writing.

By Edwin P. Jordan, M.D., and Willard C. Shepard. Pp. viii+112 with 25 figures and Appendices. Philadelphia, W. B. Saunders Company, 1952.

Geschwülste des Ohres und des Kleinhirnbrückenwinkels.

By Priv.-Doz. Dr. K. Graf, Zurich. Pp. viii+283 with 132 illustrations. Stuttgart, Georg Thieme, 1952. (Price DM 43.-)

Grundlagen Der Strahlentherapie.

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